Dartford Borough Level 1 and 2 Strategic Flood Risk Assessment

Appendices (Part 2)

February 2021

www.jbaconsulting.com

Dartford Borough Council

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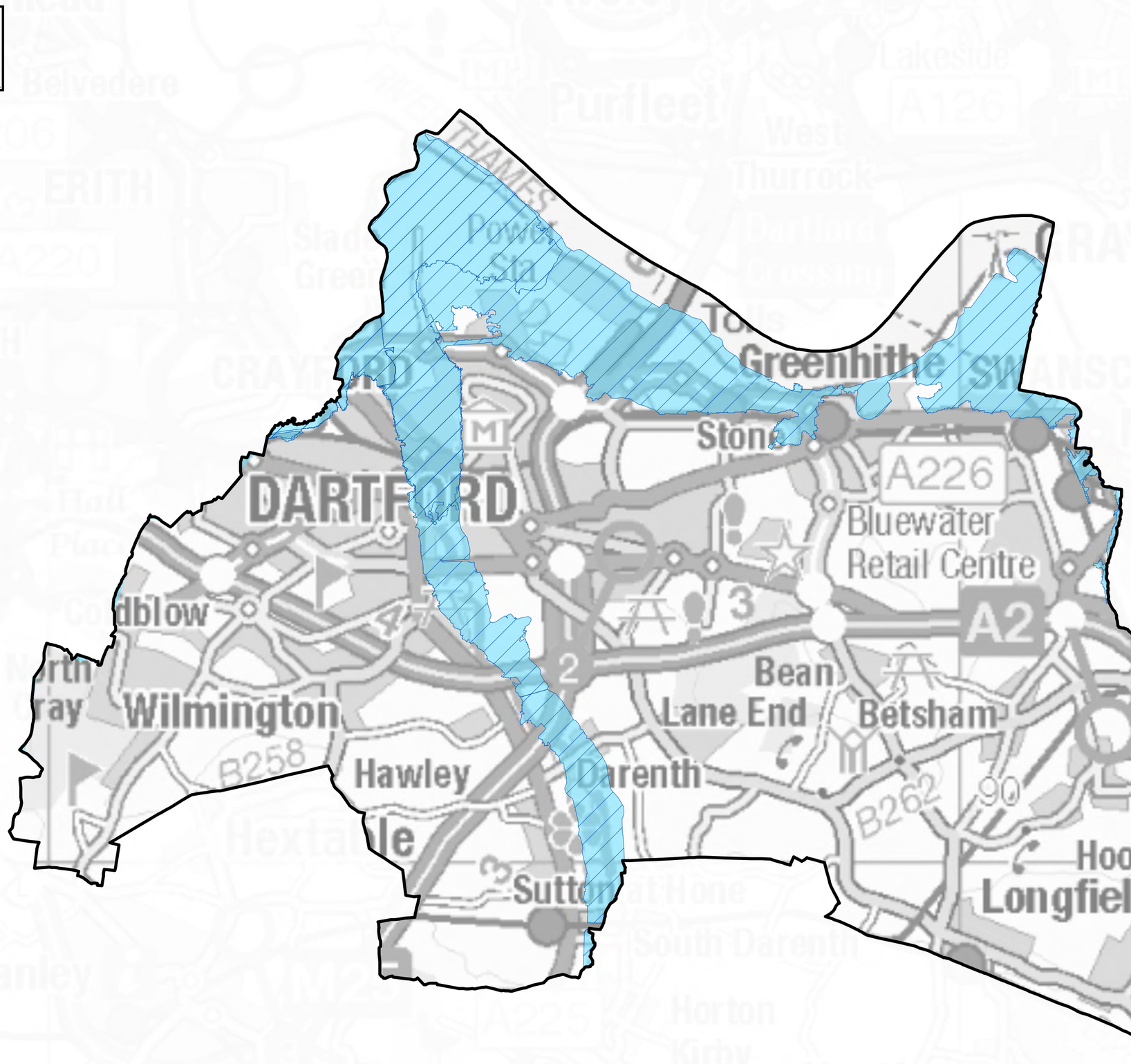
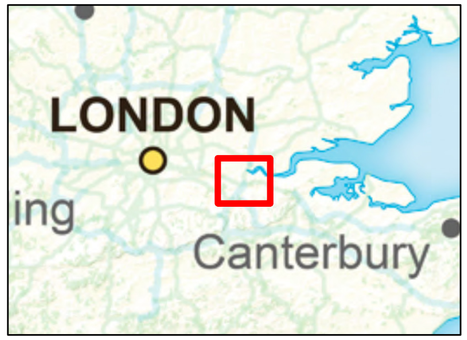
SFRA: APPENDIX J.1 ENVIRONMENT AGENCY FLOOD ALERTS AND FLOOD WARNINGS





Legend

- Dartford Borough
- Flood Warning Areas
- Flood Alert

Notes

Flood Alerts are used by the Environment Agency to warn people of the possibility of flooding and encourage them to be alert, stay vigilant and make early preparations. Flood Alerts are issued earlier than a flood warning to give notice of the possibility of flooding but before the Environment Agency are fully confident that flooding in Flood Warning Areas is expected.

Flood Warnings warn people of expected flooding and encourage them to take action to protect themselves and their property.

0 1.25 2.5 Kilometres

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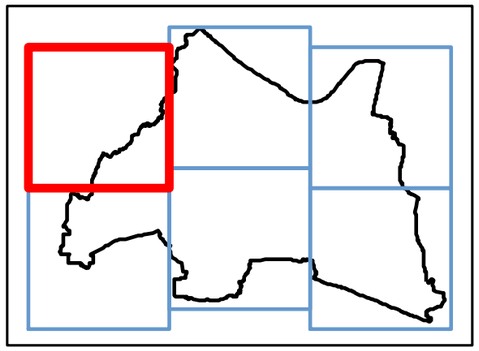
SFRA: APPENDIX J.2 ENVIRONMENT AGENCY FLOOD ALERTS AND FLOOD WARNING AREAS

Key Plan



Legend

- Dartford Borough
- Flood Warning
- Flood Alert

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0 1 2

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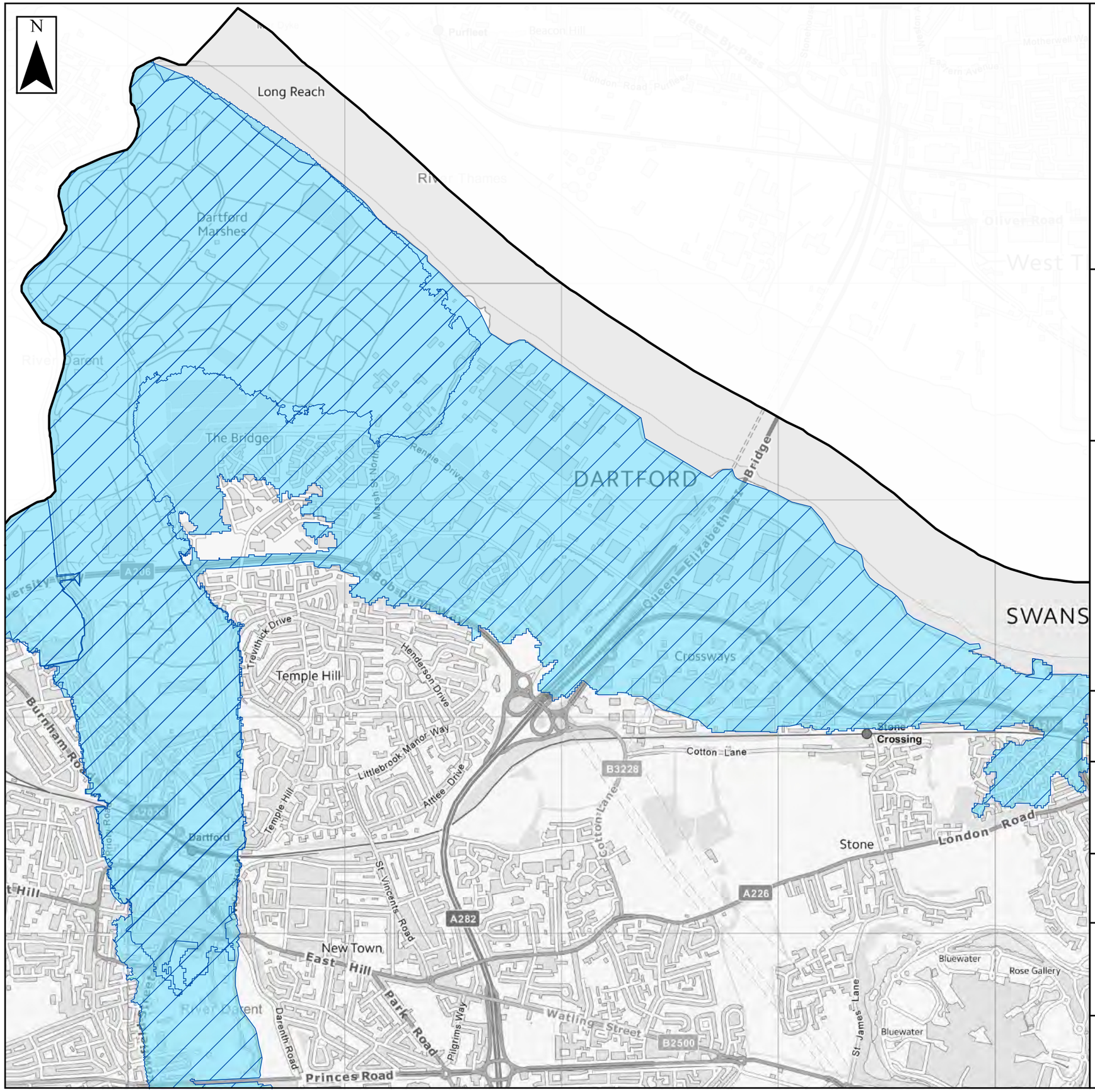

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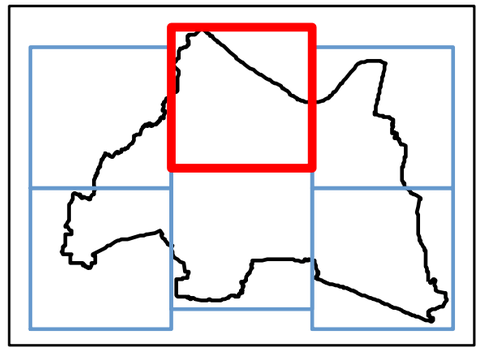

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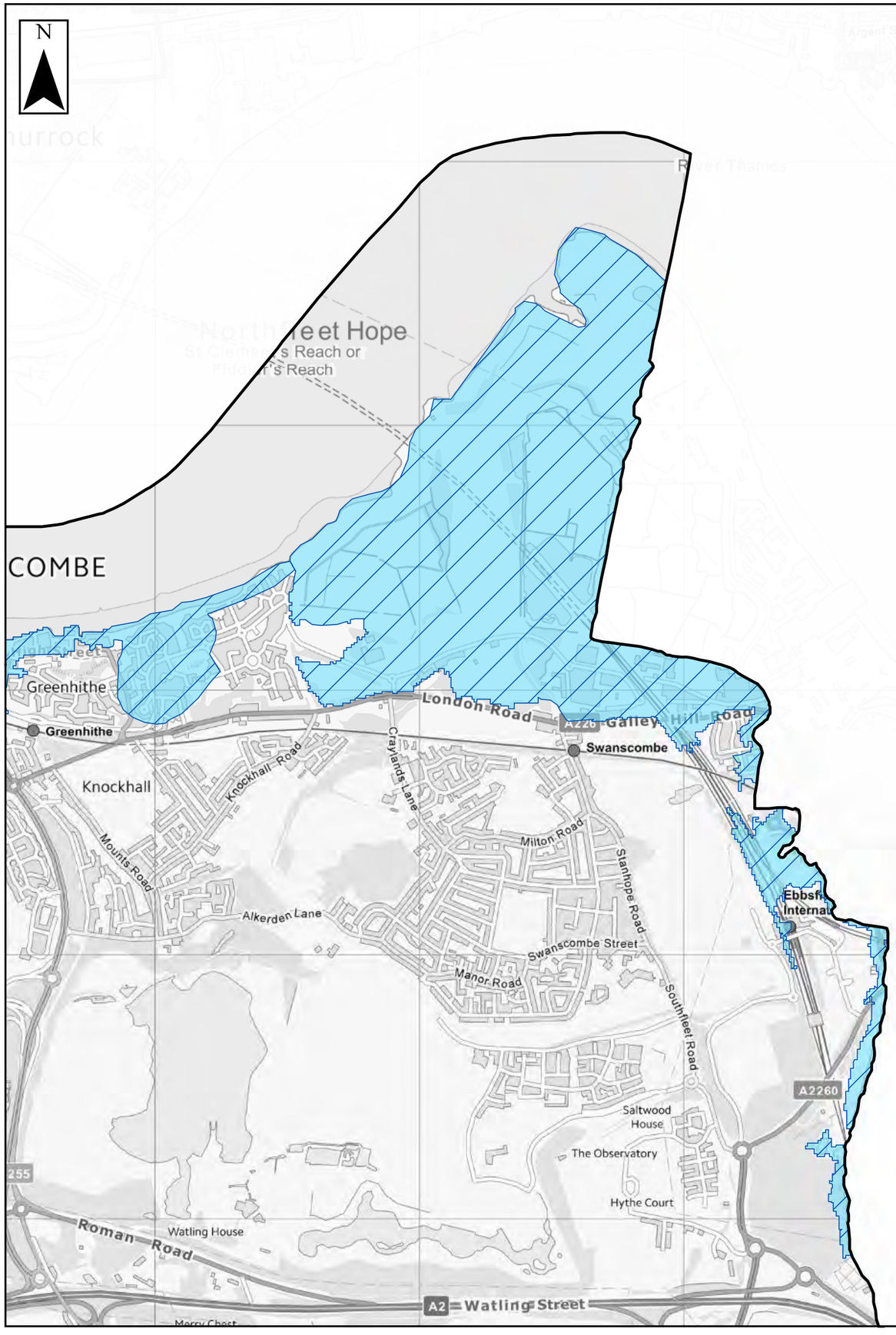

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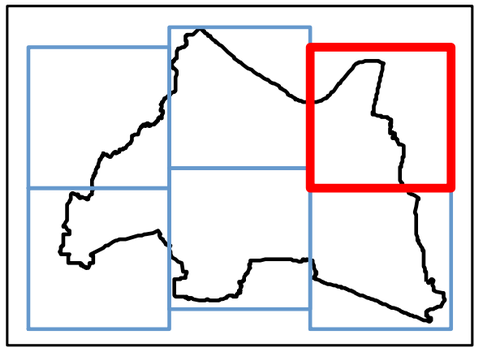

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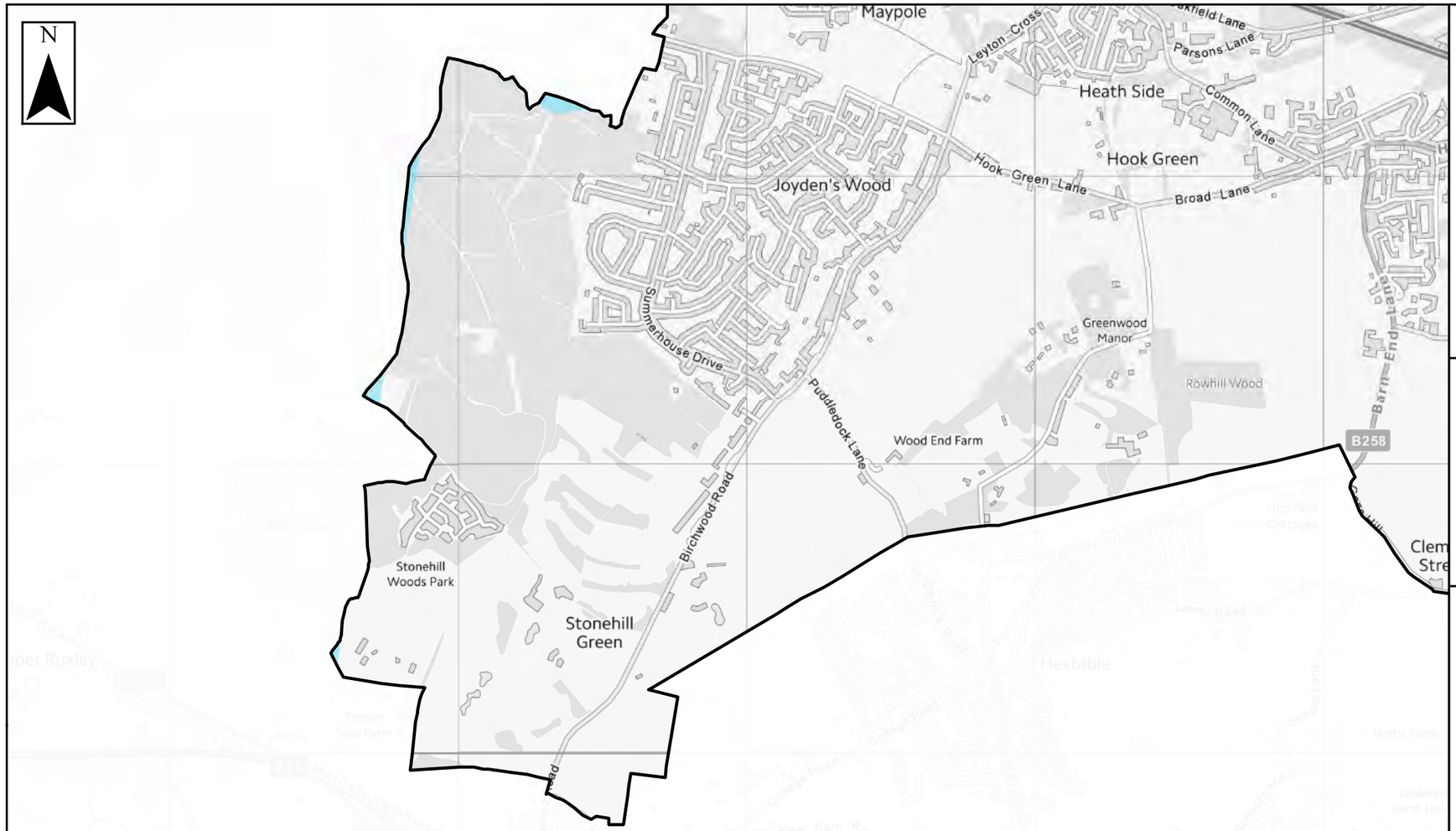

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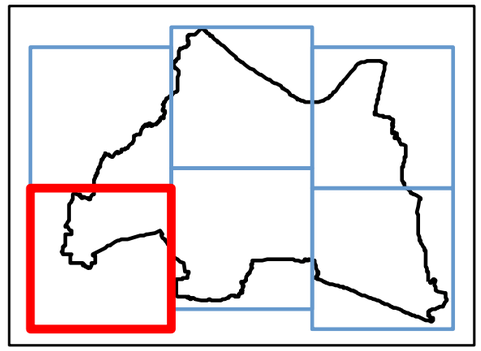

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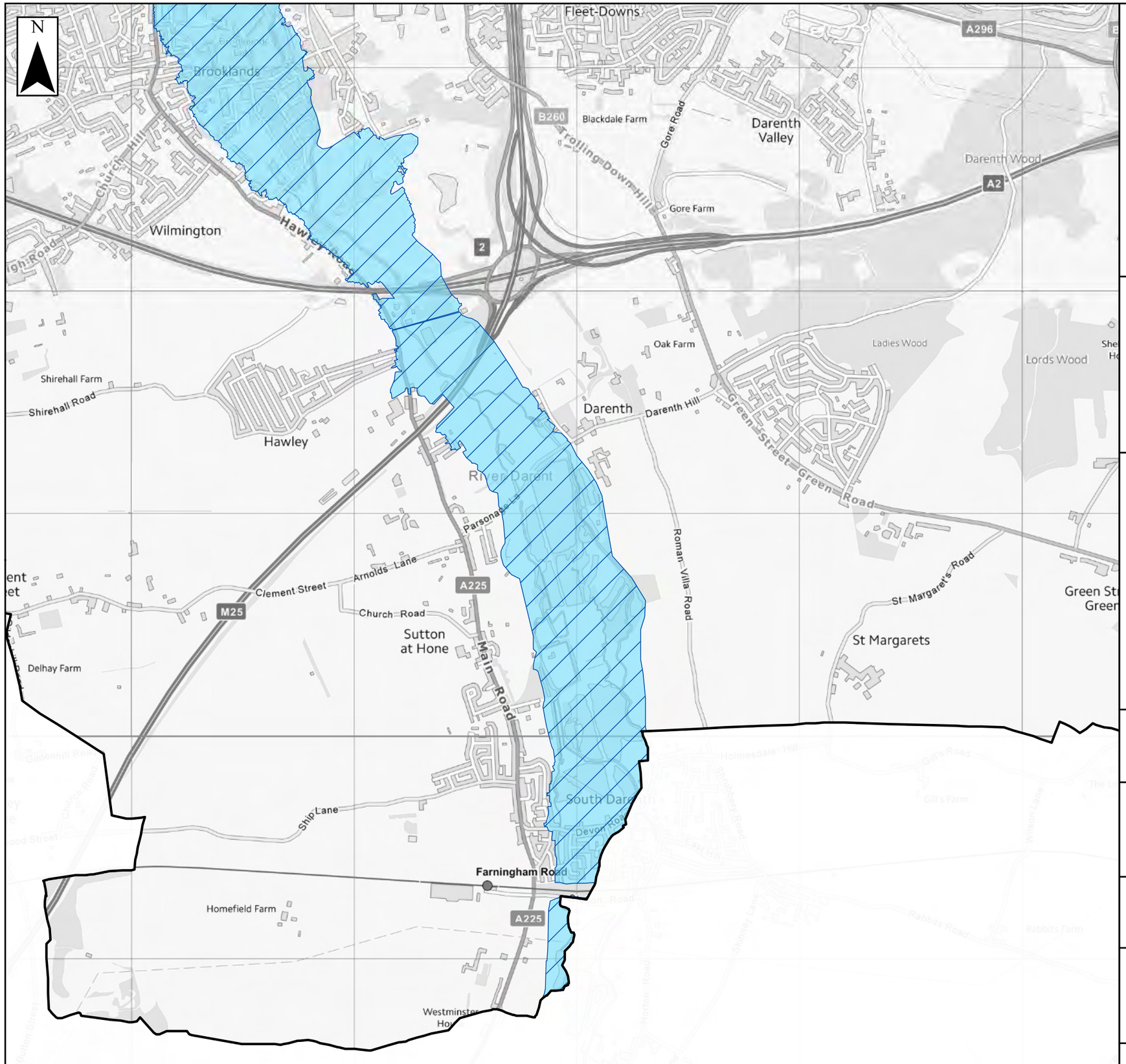

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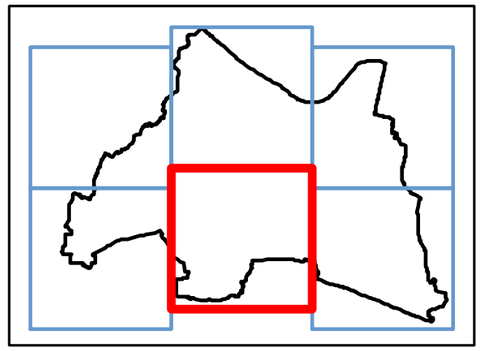

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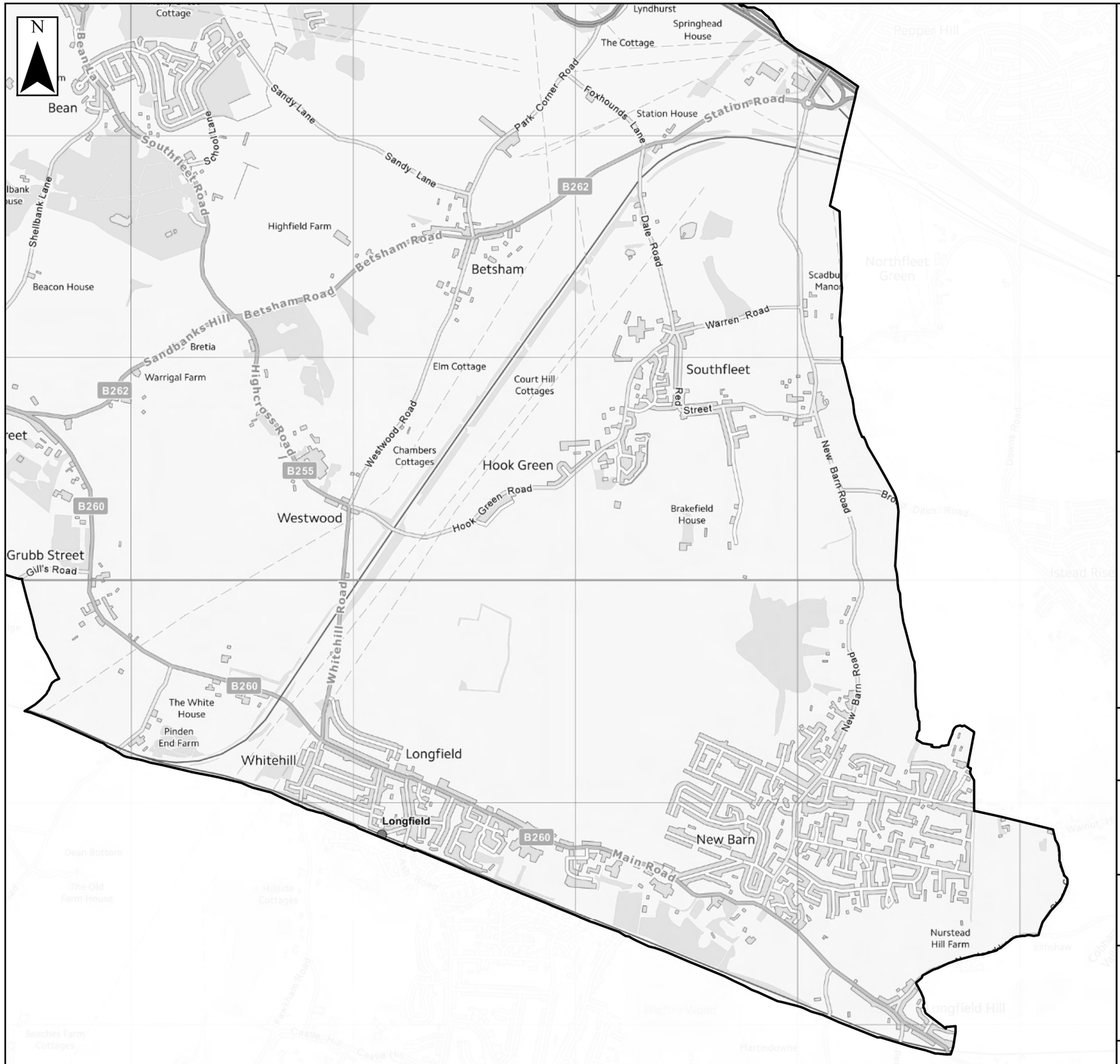

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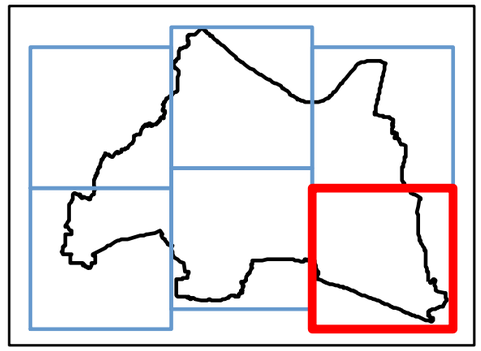

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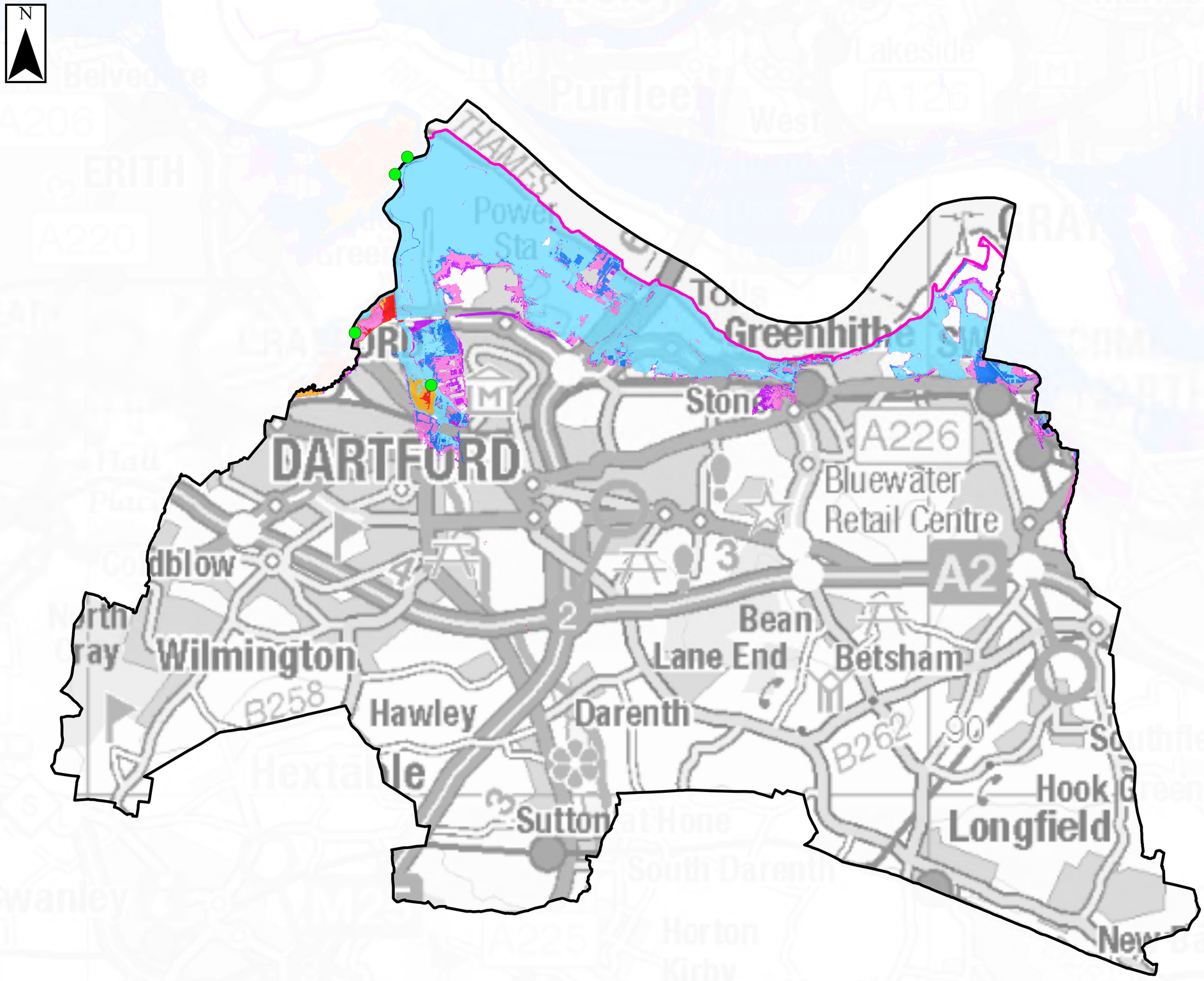
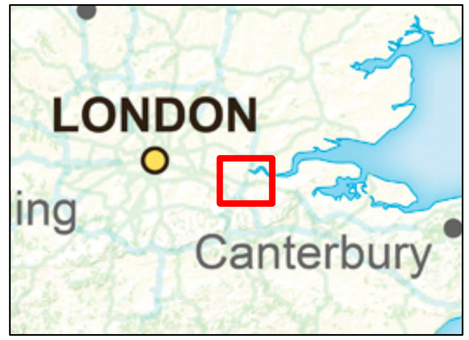
SFRA: APPENDIX K.1 MODELLED BREACH EXTENTS





Legend

- Dartford Borough

Dartford and Crayford breach modelling (2020)

- Darent and Cray modelled breach
- Modelled breach extents (0.5% AEP - Present day)
- Modelled breach extents (0.5% AEP - 2115)

Thames tidal defence breach modelling (2018)

- Modelled breaches along Thames tidal defences
- Modelled breach extents (0.5% AEP - Present Day)
- Modelled breach extents (0.1% AEP - Present Day)
- Modelled breach extents (0.5% AEP - 2115)
- Modelled breach extents (0.1% AEP - 2115)

Notes

Breaches modelled as part of the Thames tidal breach (2018) and Dartford and Crayford (2020) modelling studies are shown, with the present day risk and future risk due to climate change mapped. The total area predicted to be impacted by breach events are shown. For further information on the predicted extents for individual breaches the modelling studies should be referred to.

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0 1.25 2.5 Kilometres

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MODELLED BREACH EXTENTS

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SFRA: APPENDIX K.2 BREACH EXTENTS

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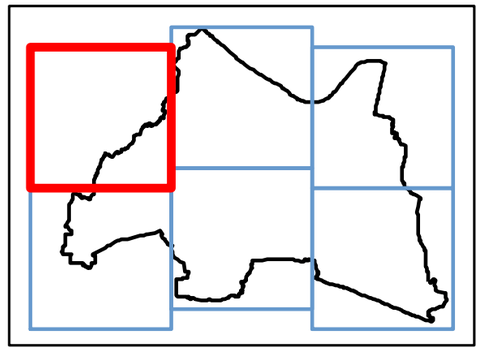
Key Plan



Legend

Dartford Borough

Dartford and Crayford breach model extents (2020)

Darent and Cray modelled breach locations

0.5% AEP - Present day

0.5% AEP - 2115

Thames tidal defence breach model extents (2018)

Modelled breaches along Thames tidal defences

0.5% AEP - Present Day

0.5% AEP - 2115

0.1% AEP - Present Day

0.1% AEP - 2115

Notes

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0 1 2

Kilometres

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BREACH EXTENTS

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N

Long Reach

River Thames

Dartford Marshes

Purfleet

Beacon Hill

Eastern Avenue

Motherwell Way

Bridge

DARTFORD

SWANS

Crossways

A206

Trevithick Drive

Henderson Drive

Temple Hill

Burnham Road

Littlebrook Manor Way

Attlee Drive

Temple Hill

Cotton Lane

B3228

Stone Crossing

Cotton Lane

Stone

London Road

A226

A282

St Vincents Road

Overy Street

New Town

East Hill

Park Road

Pilgrims Way

Watling Street

B2500

Lowfield Street

River Darent

Darenth Road

Princes Road

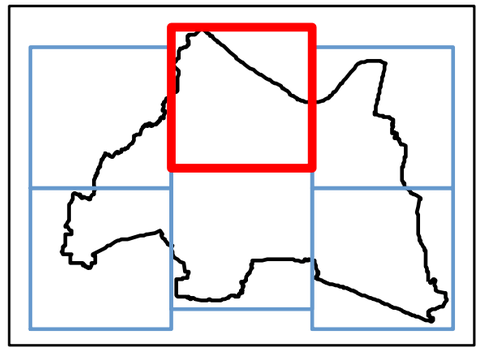
St James Lane

Bluewater

Rose Gallery

Bluewater

Key Plan



Legend

Dartford Borough

Dartford and Crayford breach model extents (2020)

Darent and Cray modelled breach locations

0.5% AEP - Present day

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Thames tidal defence breach model extents (2018)

Modelled breaches along Thames tidal defences

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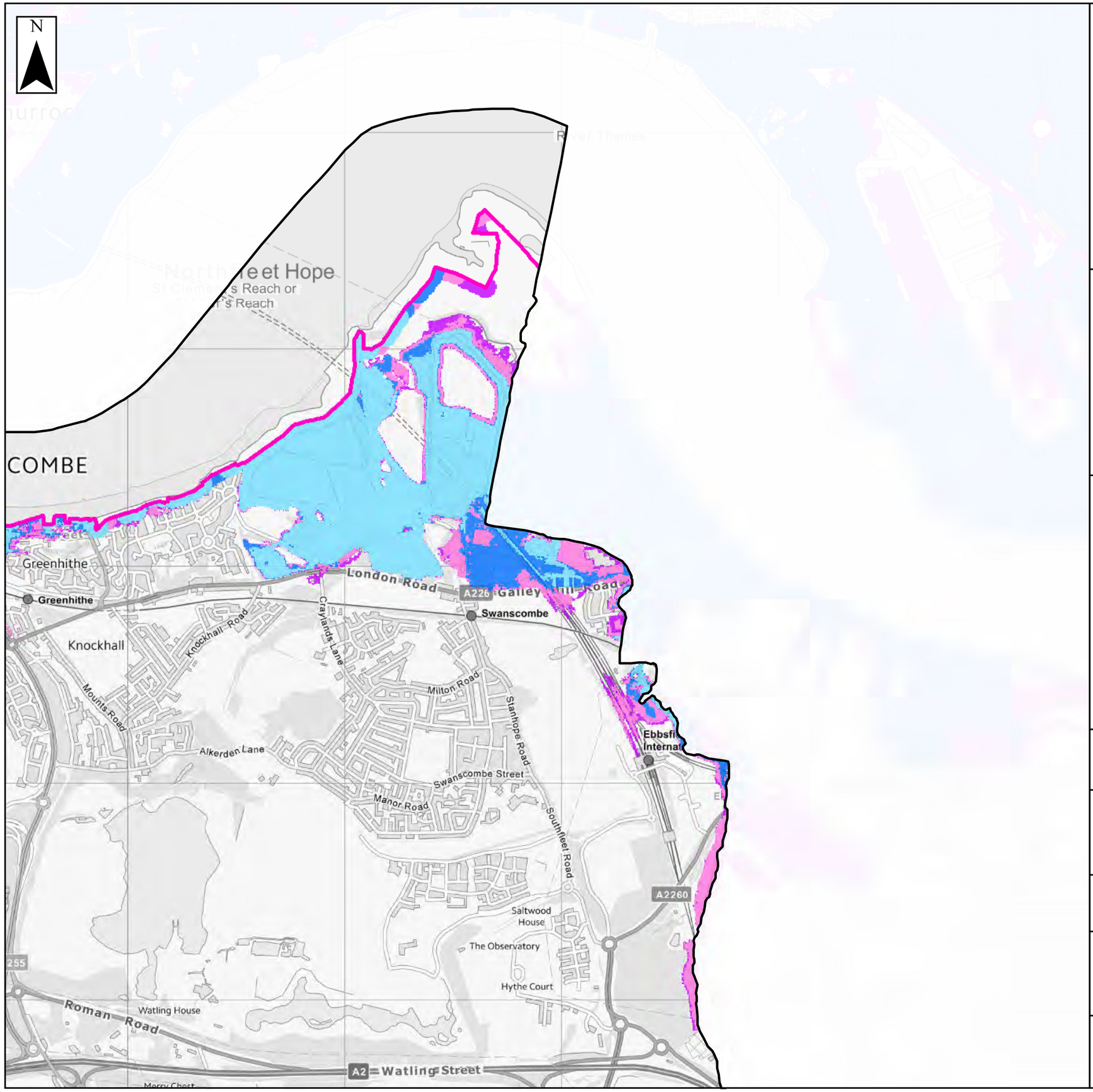

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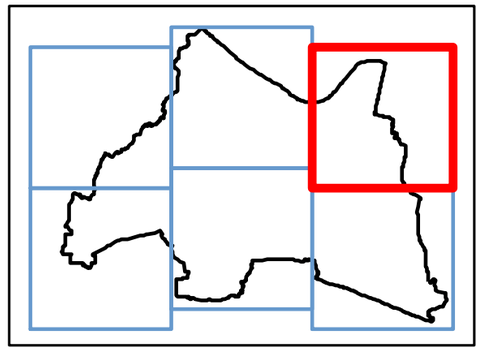

Legend

- Dartford Borough

Dartford and Crayford breach model extents (2020)

- Darent and Cray modelled breach locations
- 0.5% AEP - Present day
- 0.5% AEP - 2115

Thames tidal defence breach model extents (2018)

- Modelled breaches along Thames tidal defences
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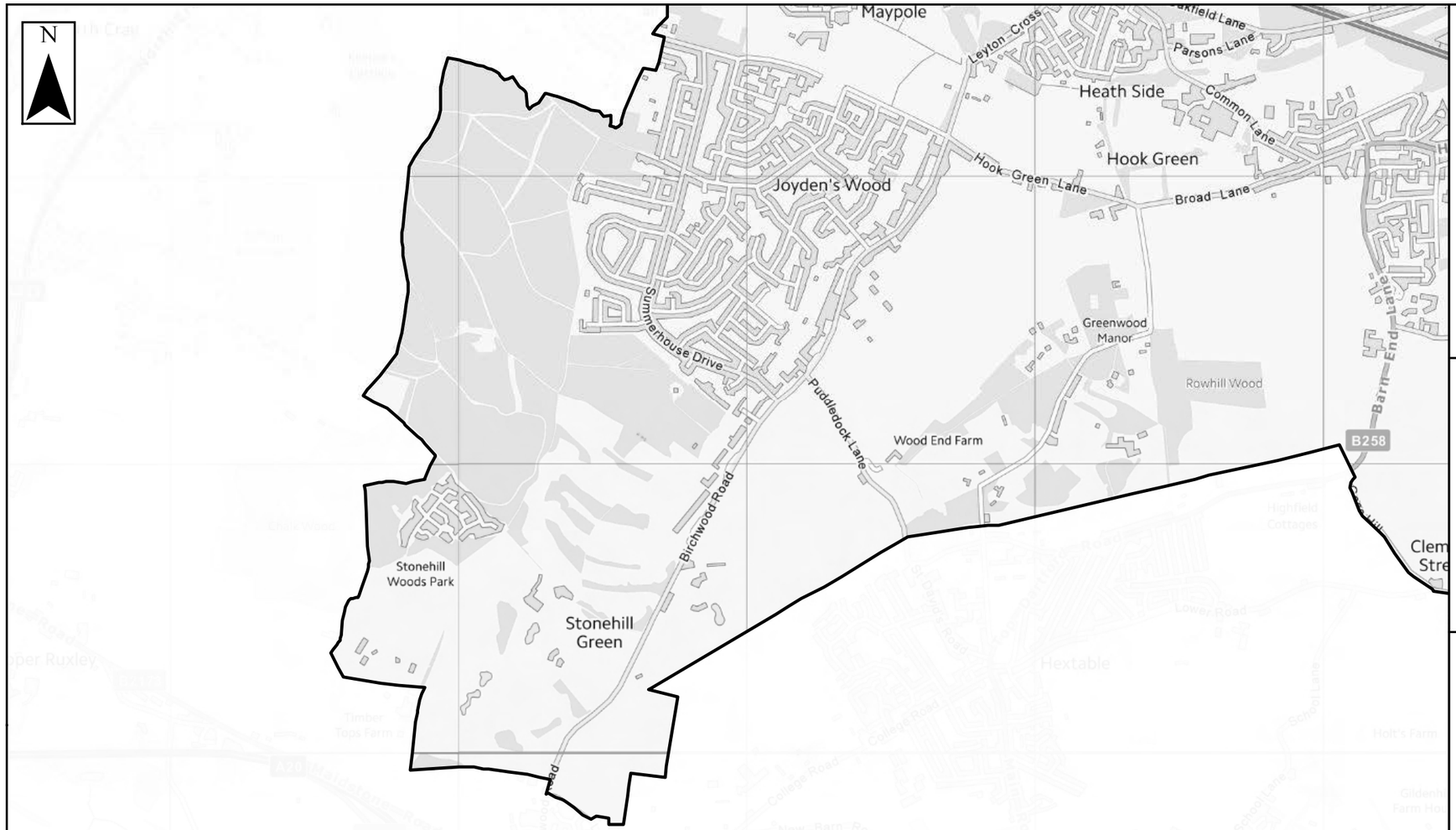

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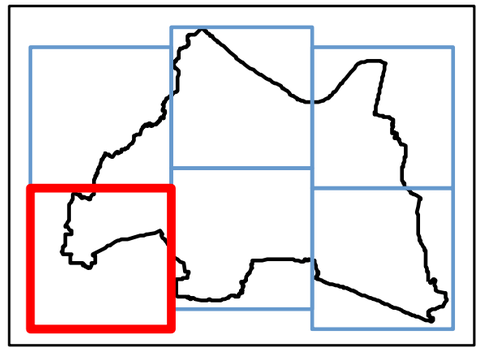

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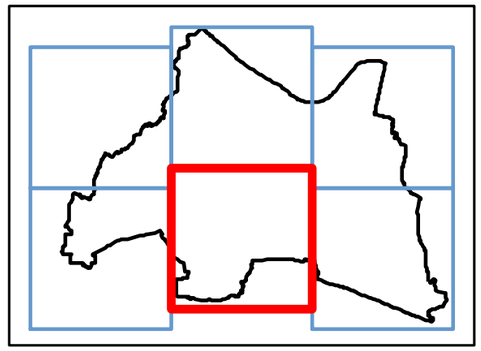

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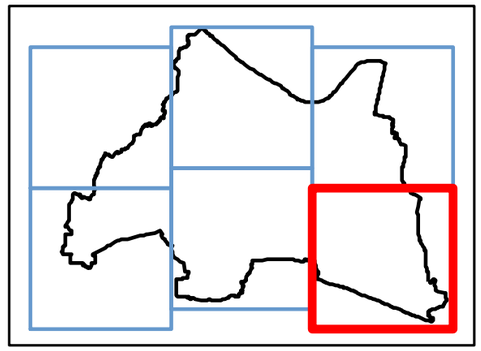

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- 0.1% AEP - 2115

Notes

Breaches modelled as part of the Thames tidal breach (2018) and Dartford and Crayford (2020) modelling studies are shown, with the present day risk and future risk due to climate change mapped. The total area predicted to be impacted by breach events are shown. For further information on the predicted extents for individual breaches the modelling studies should be referred to. For the Dartford and Crayford modelling, locations selected for testing of breach failure were based on where the Environment Agency had identified area where a defence failure could have a high impact. The possibility of breach failure at other locations is plausible and further analysis should be undertaken as part of site-specific flood risk assessments where defences are present and sites may therefore be at risk of a breach event.

0 1 2

Kilometres

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SFRA: APPENDIX K.2
BREACH EXTENTS

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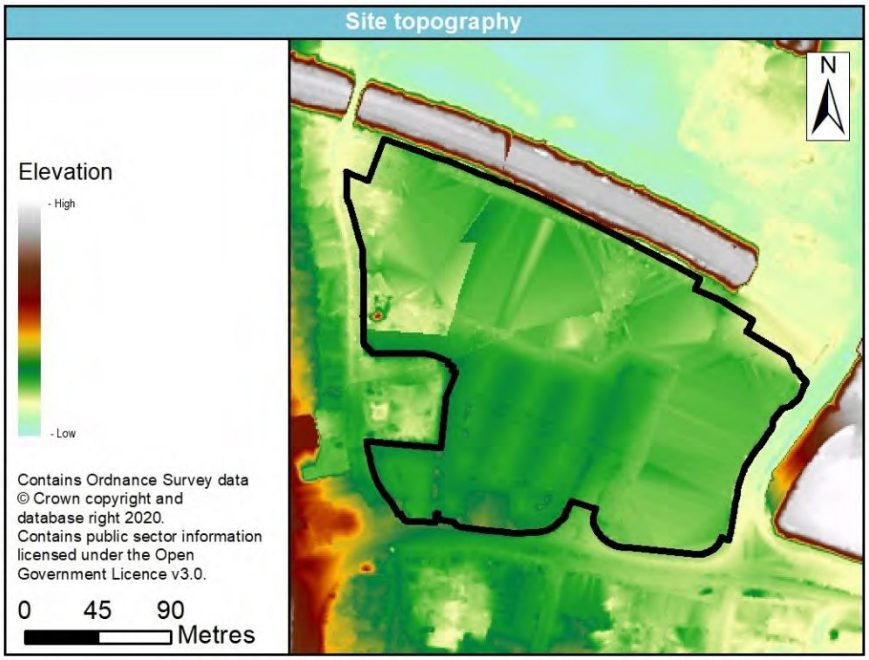
JBA consulting

DARTFORD BOROUGH COUNCIL

SFRA: APPENDIX M
LEVEL 2 SFRA
DETAILED SITE
SUMMARY TABLES

	Prospect Place

		554032 E, 174426 N
		4.44
		Commercial
		Residential and town centre uses
		More Vulnerable and less vulnerable
		 • The topography of the site is generally flat. The north-western corner of the site is lowest in elevation • The ground slope across the site generally has a gradient of less than 5% • There are a number of existing buildings across the site and which have affected localised filtering of the LIDAR data.
		The Darent and Cray (Main River) is located 220m to the east of the site.

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Site name	Prospect Place

		A small segment of the site is reported to have flooded which occurred in 1968 as a result of channel capacity exceedance and no raised defences.
		0% | 0% | 99%
		Available modelled data: The site is covered by the Environment Agency Darent and Cray (Fluvial) 2019 Flood Modeller-TUFLOW model and the Environment Agency North Kent Coast (Tidal) 2019 Flood Modeller-TUFLOW model. The extent of the Flood Zones predicted by the flood model are different to the extent of the actual flood risk, as there are flood risk management features that change the risk. **Flood characteristics:** The site is located almost entirely within Flood Zone 3a and partially within Flood Zone 2. When flood risk management features are applied, the entire site is at a negligible risk from fluvial flooding for the 5% and 1% AEP events and all tidal events. However, for the 0.1% AEP fluvial event, 99% of the site is intersected by the 0.1% AEP fluvial event. The site relies on the operation and performance of the Dartford Barrier.
		0% | 2% | 18%
		Description of surface water flow paths: Surface water accumulation occurs predominantly on the roads surrounding the site. There is no risk of surface water flooding during the 3.3% AEP event. There is a 2% increase in flood event for the 1% AEP event, with only a small strip of surface water accumulating towards the western side of the site where ground elevations are lower. There is a significant increase in risk from surface water for the 0.1% AEP where there is further expansion and development of flow routes through the site. RoFSW takes into account of building footprints so the flood risk may be affected by existing buildings on the site. It also only considers flood risk where the hazard rating is greater than 0.575. It should be noted that this dataset does not account for tide locking which could exacerbate the surface water risk at the site given the proximity of the tidally influenced Thames which could influence levels within the River Darent. Although the Dartford Barrier is located on the River Darent, risk is dependent on the operation of the barrier. The barrier shuts during extreme tidal levels in the Thames but a normal high tide occurring at the same time as a surface water event could be worsened by tide locking.
		The Areas Susceptible to Groundwater Flooding (AStGWF) dataset shows that a third of the site (western side) is located within a 1km grid square where less than 25% of the 1km grid is considered to be susceptible to groundwater flooding. The remaining area of the site is located within a 1km grid square where between 25-50% of the 1km grid is considered to be susceptible to ground water flooding.

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Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

Site name	Prospect Place

		The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.
		The Environment Agency Risk of Flooding from Reservoirs dataset does not show the site to be at risk of reservoir flooding.

Site name	Prospect Place

		Concrete Wall	0.1% AEP	2
		Earth Embankment	0.1% AEP	3
		Bridge Abutment	0.1% AEP	2
		Dartford Barrier and Thames tidal defences	0.1% AEP	-
			There are no culverts located within the site which could present a residual risk in the event of a blockage	
			The site is not at risk of flooding due to reservoir breach	
			The Thames tidal defences pose a residual risk to the site in the event of a breach. Modelling was undertaken in 2018 to assess the risk of breach from these defences. Results of modelling show that the site is intersected by 0.5% AEP (present day) extent. This impacts 1% of the site with land situated at low elevations towards the north-eastern corner of the site. There is an increase in extent to 25% of the site at risk for the 0.1% AEP (present day) breach event. In the future, the site is predicted an increase in risk to 98% for both the 0.5% and 0.1% AEP (2115 Upper End) breach event. Majority of the site is predicted to be at risk due to climate change in the future.	
			The site also benefits from flood risk management infrastructure along the River Darent. Breach modelling was undertaken at the Dartford Industrial Park/ Priory Road (Left Bank) for the 0.5% AEP (present day and 2115 Upper End). Results show that the site is not at risk from this breach location. However, as there are flood risk management infrastructures along the Darent and Cray river, the site could be at risk from defence breach or overtopping.	
		The site is situated within the River Darent at Dartford Trade Park, Brooklands and Dartford to the Thames estuary (064FWF7Dartford) and the Dartford, Crayford and Greenhithe (064FWT1Dartford) Flood Warning Areas. The site is also situated within the River Darent from Westerham to Dartford (064WAF7Darent) and the Coast from Dartford to Allhallows (064WAT1ThamesEst) Flood Alert Areas.		

Site name	Prospect Place

		Safe access and egress for the site may be available during flood events up to 0.1% AEP via any of the surrounding roads such Priory Road to the west, and Highfield Road North to the south and east of the site. However, during the 01% AEP fluvial flood event, access and egress may only be abale via the south-west corner of the site along Priory Place or Highfield Road North due to the entire site predicted to at risk of flooding. Safe access and egress may be available to the south-west of the site during a 1% AEP plus 35% or 70% fluvial flood event given large parts of the site to the east and north is predicted to be at risk of flooding. Additionally, access and egress routes may need to account for surface water flooding along Highfield Road North and Priory Road.

	Thames	n/a	35% increase in peak river flows	70% increase in peak river flows
		0%	1%	68%

	There is an increase in extent for all climate change allowances in comparison to the present day 1% AEP flood extent (not predicted to be at risk). The flood extent for the Upper End (+70%) scenario exceeds that of that of the Higher Central extent and present day but does not reach that of the 0.1% AEP flood extent (99%). Therefore, the site will be at a higher risk from fluvial flooding in the future. The site is affected by flood risk both under existing conditions and in the future. A commitment will be required to measures so that development is safe and third parties are not adversely affected by proposals. This could potentially be achieved by provision of wider strategic measures, site specific measures, or a combination of these.

2%	4%	7%

	A small increase in flood extent during the 1% AEP surface water event is predicted for the plus 20% and 40% climate change events. However, the extents do not reach that of the 0.1% AEP surface water flood event. Therefore, the site will be a slightly higher risk from surface water flooding in the future. However, it should be noted that this dataset does not take account of the impact of tide locking from increased sea levels on drainage from the site which could exacerbate the surface water risk at the site in the future.

Site name	Prospect Place

		The entire site's bedrock geology consists of White Chalk.
		The entire site is overlain by alluvium (clay, silt, and sand)
		The parcels are overlain by loamy and clayey floodplain or coastal flat soils with naturally high groundwater.
		The site is not located within a Groundwater Source Protection Zone.
		There is a historic landfill site located 261m south-east of the site.

Site name	Prospect Place

		Implementation of SuDS at the site could provide opportunities to deliver multiple benefits including volume control, water quality, amenity and biodiversity. This could provide wider sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. British Geological Society (BGS) data indicates that the underlying geology is the White Chalk subgroup, though the soils at the site are loamy and clayey with high groundwater levels. Groundwater levels and the permeability of soils at the site should be assessed via an infiltration test, with the use of infiltration maximised as much as possible. Off-site discharge in accordance with the SuDS hierarchy may be required to discharge surface water runoff from the site. Groundwater ingress could potentially impact the hydraulic capacity and structural integrity of detention and attenuation features, if measures to prevent this are not implemented in the design of the surface water drainage system. Given the high-density nature of the site, use of urban SuDS is recommended. Urban sites should not preclude the use of SuDS. It may be possible to reduce site runoff by maximising the permeable surfaces on site using a combination of permeable surfacing and soft landscaping techniques. Mapping suggests that the site slopes make it possible to consider most forms of dentition. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. The potential to utilise conveyance features such as swales to intercept and convey surface water runoff should be considered. Conveyance features should be located on common land or public open space to facilitate ease of access. Where slopes are >5%, features should follow contours or utilise check dams to slow flows. Overland flows paths are present at the development site along highways and in the south of the eastern parcel. Where possible opportunities to incorporate these flow paths into the site layout should be considered. If it is proposed to discharge runoff to the River Darent or sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and discharge rate agreed with the asset owner. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA. Surface water outfalls that discharge into the River Darent may be affected by tide locking due to water levels in the River Darent. The impacts of tide locking/flood flows will need to be considered in terms of the attenuation storage requirements of the site. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints.

Site name	Prospect Place

		The site is located within a catchment with a high sensitivity to development. . The Implications of increased volumes both generated by the development and potentially affecting it should be addressed at an appropriate catchment level to demonstrate that additional volumes from upstream or at the site do not exacerbate flood risk at vulnerable locations remote from the site. This exercise should also consider whether the site is potentially affected by proposed development upstream.

0%	**1%**	**99%**	**0%**

The Sequential Test must be satisfied based on fluvial and other sources of flood risk before the Exception test is applied.

The Exception test will be required in the following scenario:

- highly vulnerable and in flood zone 2
- essential infrastructure in flood zone 3a or 3b
- more vulnerable in flood zone 3a

Development will not be permitted for the following scenario:

- Highly vulnerable development within FZ3a.
- Highly vulnerable, More vulnerable and / or Less vulnerable development within FZ3b.

Flood risk assessment

- At the planning application stage, a site-specific flood risk assessment will be required for this site as it is greater than 1ha, located within Flood Zone 2 and 3 and may be subject to other sources of flooding where the development would introduce a more vulnerable use and contains land identified in the strategic flood risk assessment as being at increased flood risk in the future. It is also required where development:
  - Is on land which has been identified by the Environment Agency as having critical drainage problems; or
  - Other sources of flooding must be considered as part of any site-specific flood risk assessment, including surface water and groundwater.
  - Consideration should be given to the potential effects of climate change, particularly with respect to surface water. Proposals should consider the opportunity to include measures that provide for a reduction in predicted surface water flood risk at existing development.
  - Breach modelling should be undertaken on the River Darent as the watercourse benefits from flood risk management infrastructure
  - Climate change modelling should be undertaken using the relevant allowances for the type of development and level of risk.
  - Where there is a reasonable likelihood of multiple sources of flood risk having significant impact, it is recommended that consideration is given to assessing the combined risks of these.
  - Consultation with the Local Authority, Lead Local Flood Authority and Environment Agency should be undertaken at an early stage.
  - Proposals will need to demonstrate that the site can adopt a sequential approach with more vulnerable uses located in lower risk parts of the site where possible.
  - Consideration must be given to the flood risk management measures and commitments required to make development safe over the intended lifetime.
  - Cumulative effects should be considered (see above).

Site name	Prospect Place

	Guidance for site design and making development safe:
	• New development must seek opportunities to reduce the overall level of flood risk at the site. For example, by:
	  ○ Reducing volume and rate of runoff
	  ○ Relocating development to zones with lower flood risk
	  ○ Creating space for flooding.
	• Safe access and egress should be demonstrated in the fluvial plus climate change events. Consideration should also be given to providing safe access and egress during surface water events.
	• The Environment Agency has confirmed that more vulnerable uses should be set above the climate change flood level with a freeboard allowance, and developments should not displace water or block flow routes. Detailed proposals for the site will need to be developed in consultation with the Environment Agency.
	• All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post development runoff.
	• Ground investigations at the site should be undertake to confirm groundwater levels and the permeability of soils to support the design of SUDS features.
	• SuDS should be designed to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc.
	• Example features include swales, attenuation features, green roofs, rainwater capture and reuse and permeable paving.
	• Assessment of runoff should include allowances for climate change effects.
	• Efforts should be made to limit runoff to greenfield rates and discharge rates from the site should not increase downstream flood risk.
	• SuDS design must follow Kent County Council policy, meet the Defra National Non-Statutory Technical Standards, and follow current best practice (CIRIA C752 Manual 2015).

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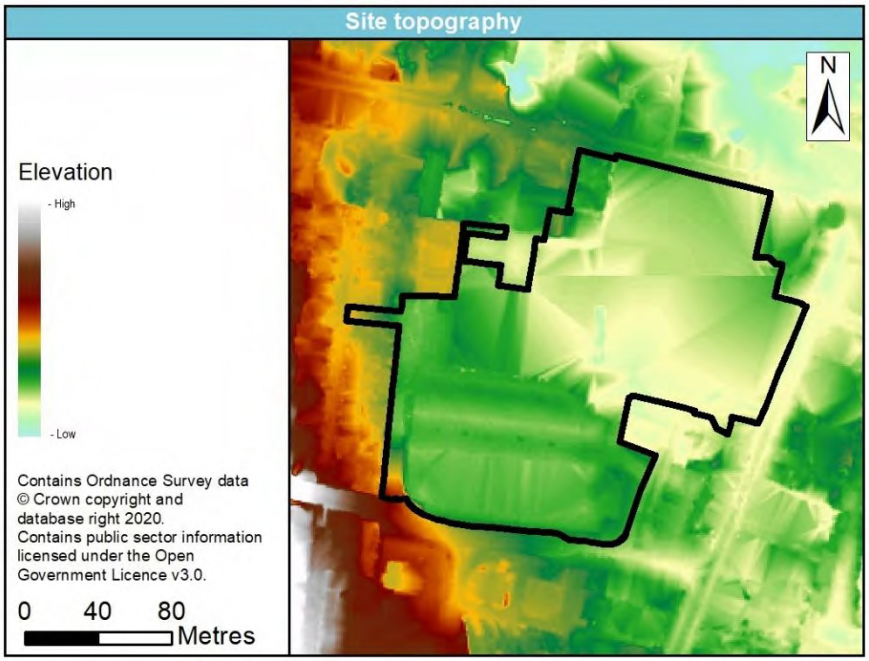
	Priory Shopping Centre

		554054 E, 173959 N
		3.1
		Commercial
		Residential and town centre uses
		More Vulnerable and less vulnerable
		 • The topography of the site slopes inwards where the lowest elevation is located near the centre • There are existing buildings at the site • The ground slope across the site generally has a gradient of less than 5%. • There are a number of existing buildings across the site and which have affected localised filtering of the LIDAR data.
		The Darent and Cray (Main River) is located 235m to the east of the site.

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Site name	Priory Shopping Centre

The Environment Agency's recorded flood outlines dataset indicates that the site has not previously flooded.

Kent County Council may hold additional records which are not available at this time. These records detail historical flood incidents from all sources, whereas the Environment Agency dataset only records incidents of fluvial, tidal or coastal flooding. The Lead Local Flood Authority should be contacted to obtain further details.

0%	0%	97%

Available modelled data:

The site is covered by the Environment Agency Darent and Cray (Fluvial) 2019 Flood Modeller-TUFLOW model and the Environment Agency North Kent Coast (Tidal) 2019 Flood Modeller-TUFLOW model. The extent of the Flood Zones predicted by the flood model are very similar to the extent of the actual flood risk at the site.

Flood characteristics:

The site is at a negligible risk of fluvial flooding for the 5% and 1% AEP flood events. The entire site apart from a very small section towards the south-west corner is within the 0.1% AEP fluvial event.

When the Dartford Barrier is closed there is a negligible risk of tidal flooding to the site, though in the North Kent Coast undefended scenario the site is only predicted to be impacted by tidal flooding during the 0.1% AEP event.

8%	19%	44%

Description of surface water flow paths:

Surface water accumulation occurs in the 3.3% AEP event predominantly on the roads surrounding the site, in particular Lowfield Street, the northern end of Spring Vale North, and along a side street off Instone Road. Risk from surface water flooding over doubles between each AEP with development of flow routes through the site between the two side streets off Instone Road. Nearly half the site at risk during the 0.1% AEP event.

RoFSW takes into account of building footprints so the flood risk may be affected by existing buildings on the site. It also only considers flood risk where the hazard rating is greater than 0.575.

It should be noted that this dataset does not account for fluvial "locking" during periods of high river flows and levels of any outfalls discharging to the Darent which could exacerbate the surface water risk at the site.

The Areas Susceptible to Groundwater Flooding (AStGWF) dataset shows that a third of the site (western side) is located within a 1km grid square where less than 25% of the 1km grid is considered to be susceptible to groundwater flooding. The remaining area of the site is located within a 1km grid square where between 25-50% of the 1km grid is considered to be susceptible to ground water flooding.

Site name	Priory Shopping Centre

		The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.
		The Environment Agency Risk of Flooding from Reservoirs dataset does not show the site to be at risk of reservoir flooding.

Site name	Priory Shopping Centre

		High Ground	5%-1% AEP	2-3
		Earth Embankment	2%-1% AEP	2-3
		Concrete Wall	1% AEP	3
			There are no culverts located within the site which could present a residual risk in the event of a blockage	
			The site is not at risk of flooding due to reservoir breach	
			Modelling was undertaken in 2018 to assess the residual risk from a breach in the Thames tidal defences. Results of the modelling show that the site is not intersected by present day extents. The site is also predicted to not be impacted by climate change in the future (2115 Upper End).	
			The site benefits from flood risk management infrastructure along the River Darent. Breach modelling was undertaken at the Dartford Industrial Park/ Priory Road (Left Bank) for the 0.5% AEP (present day and 2115 EPOCH). Results show that the site is not at risk from this breach location. However, as there are flood risk management infrastructures along the Darent and Cray river, the site could be at risk from defence breach or overtopping.	
		The site is situated within the River Darent at Dartford Trade Park, Brooklands and Dartford to the Thames estuary (064FWF7Dartford) and the Dartford, Crayford and Greenhithe (064FWT1Dartford) Flood Warning Areas. The site is also situated within the River Darent from Westerham to Dartford (064WAF7Darent) and the Coast from Dartford to Allhallows (064WAT1ThamesEst) Flood Alert Areas.		
		Safe access and egress for the whole site may be available up the 0.1% AEP fluvial flood event by any of the surrouding access roads. However, as the entire site is intersected by the 0.1% AEP fluvial flood extent, safe access and agrees may be available via the souther-west corner on Instone Road. A significant flow route is highlighed across the southern half of the site during present day surface water flood events, safe access and egress may be availabe on Instone Road and Spital Street. Safe acess and egress for the south and south-west corners of the site may be available during the 1% AEP plus 35% or 70% fluvial event given large parts of the site to the north and surrounding land is predicted to be at risk of flooding. Additionally, access and egress routes along Instone Road and Spital Street may need to account for surface water flooding.		

Site name	Priory Shopping Centre

		Thames	n/a	35% increase in peak river flows	70% increase in peak river flows
			0%	36%	54%
		There is an increase in extent for all climate change allowances in comparison to the present day 1% AEP flood extent (not predicted to be at risk). The northern area of the site is at most risk from fluvial climate change flooding. The southern area of the site is not intersected by any flood extents. The flood extent for the Upper End (+70%) scenario far exceeds that of that of the Higher Central extent and present day but does not reach that of the 0.1% AEP flood extent (98%). Therefore, the site will be at a slightly higher risk from fluvial flooding in the future. The site is affected by flood risk both under existing conditions and in the future. A commitment will be required to measures so that development is safe, and third parties are not adversely affected by proposals. This could potentially be achieved by provision of wider strategic measures, site specific measures, or a combination of these.			
		19%	23%	28%	
		A slight increase in flood extent during the 1% AEP surface water event is predicted for the plus 20% and 40% climate change events. However, the extents do not reach that of the 0.1% AEP event. These increases are located towards the southern area of the site, linking the two side roads leading from Instone Road.			

Site name	Priory Shopping Centre

		The entire site's bedrock geology consists of White Chalk.
		The entire site is overlain by alluvium (clay, silt and sand)
		The site is overlain by loamy and clayey floodplain or coastal flat soils with naturally high groundwater.
		The site is not located within a Groundwater Source Protection Zone.
		There is a historic landfill site located 715m south-west of the site.

Site name	Priory Shopping Centre

		Implementation of SuDS at the site could provide opportunities to deliver multiple benefits including volume control, water quality, amenity and biodiversity. This could provide wider sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. British Geological Society (BGS) data indicates that the underlying geology is the White Chalk subgroup, though the soils at the site are loamy and clayey with high groundwater levels. Groundwater levels and the permeability of soils at the site should be assessed via an infiltration test, with the use of infiltration maximised as much as possible. Off-site discharge in accordance with the SuDS hierarchy may be required to discharge surface water runoff from the site. Groundwater ingress could potentially impact the hydraulic capacity and structural integrity of detention and attenuation features, if measures to prevent this are not implemented in the design of the surface water drainage system. Given the high-density nature of the site, use of urban SuDS is recommended. Urban sites should not preclude the use of SuDS. It may be possible to reduce site runoff by maximising the permeable surfaces on site using a combination of permeable surfacing and soft landscaping techniques. Mapping suggests that the site slopes make it possible to consider most forms of dentition. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. The potential to utilise conveyance features such as swales to intercept and convey surface water runoff should be considered. Conveyance features should be located on common land or public open space to facilitate ease of access. Where slopes are >5%, features should follow contours or utilise check dams to slow flows. Overland flows paths are present at the development site along highways and in the south of the eastern parcel. Where possible opportunities to incorporate these flow paths into the site layout should be considered. If it is proposed to discharge runoff to the River Darent or sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and discharge rate agreed with the asset owner. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA. Surface water outfalls that discharge into the River Darent may be affected by tide locking due to water levels in the River Darent. The impacts of tide locking/flood flows will need to be considered in terms of the attenuation storage requirements of the site. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints.

Site name	Priory Shopping Centre

The site is located within a catchment with a high sensitivity to development. The Implications of increased volumes both generated by the development and potentially affecting it should be addressed at an appropriate catchment level to demonstrate that additional volumes from upstream or at the site do not exacerbate flood risk at vulnerable locations remote from the site. This exercise should also consider whether the site is potentially affected by proposed development upstream.

3%	**97%**	**0%**	**0%**

The Sequential Test must be satisfied based on fluvial and other sources of flood risk before the Exception test is applied.

The Exception test will be required in the following scenario:

- highly vulnerable and in flood zone 2
- essential infrastructure in flood zone 3a or 3b
- more vulnerable in flood zone 3a

Development will not be permitted for the following scenario:

- Highly vulnerable development within FZ3a.
- Highly vulnerable, More vulnerable and / or Less vulnerable development within FZ3b.

Flood risk assessment

- At the planning application stage, a site-specific flood risk assessment will be required for this site as it is greater than 1ha, located within Flood Zone 2 and may be subject to other sources of flooding where the development would introduce a more vulnerable use and contains land identified in the strategic flood risk assessment as being at increased flood risk in the future. It is also required where development:
  - Is on land which has been identified by the Environment Agency as having critical drainage problems; or
  - Other sources of flooding must be considered as part of any site-specific flood risk assessment, including surface water and groundwater.
  - Consideration should be given to the potential effects of climate change, particularly with respect to surface water. Proposals should consider the opportunity to include measures that provide for a reduction in predicted surface water flood risk at existing development.
  - Breach modelling should be undertaken on the River Darent as the watercourse benefits from flood risk management infrastructure.
  - Climate change modelling should be undertaken using the relevant allowances for the type of development and level of risk.
  - Where there is a reasonable likelihood of multiple sources of flood risk having significant impact, it is recommended that consideration is given to assessing the combined risks of these.
  - Consultation with the Local Authority, Lead Local Flood Authority and Environment Agency should be undertaken at an early stage.
  - Proposals will need to demonstrate that the site can adopt a sequential approach with more vulnerable uses located within lower risk parts of the sitewhere possible.
  - Consideration must be given to the flood risk management measures and commitments required to make development safe over the intended lifetime.
  - Cumulative effects should be considered (see above).

Site name	Priory Shopping Centre

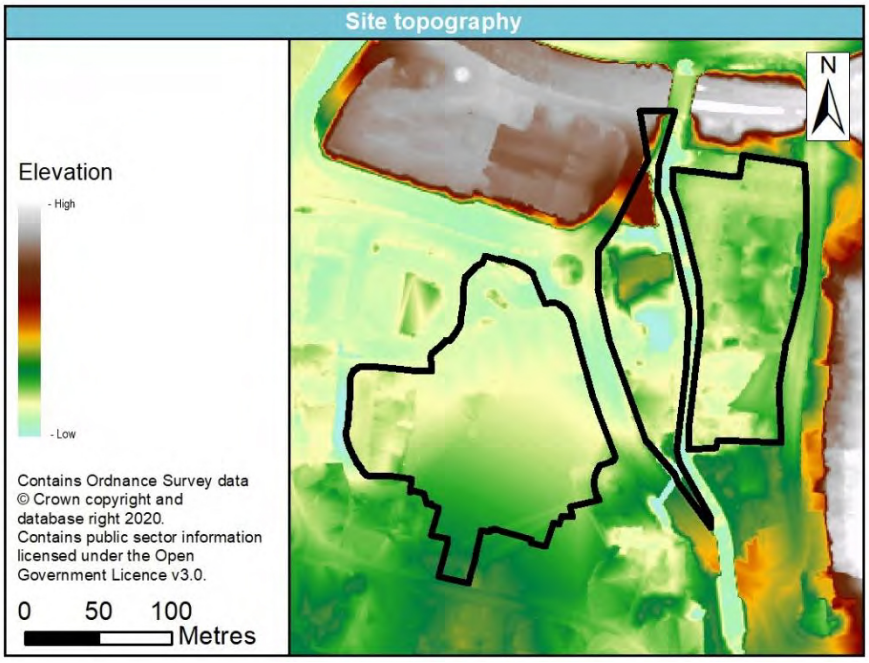
Guidance for site design and making development safe:

- New development must seek opportunities to reduce the overall level of flood risk at the site. For example, by:
  - Reducing volume and rate of runoff
  - Relocating development to zones with lower flood risk
  - Creating space for flooding.
- Safe access and egress should be demonstrated in the fluvial plus climate change events. Consideration should also be given to providing safe access and egress during surface water events.
- The Environment Agency has confirmed that more vulnerable uses should be set above the climate change flood level with a freeboard allowance, and developments should not displace water or block flow routes. Detailed proposals for the site will need to be developed in consultation with the Environment Agency.
- All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post development runoff.
- Ground investigations at the site should be undertaken to confirm groundwater levels and the permeability of soils to support the design of SUDS features.
- SuDS should be designed to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc.
- Example features include swales, attenuation features, green roofs, rainwater capture and reuse and permeable paving.
- Assessment of runoff should include allowances for climate change effects.
- Efforts should be made to limit runoff to greenfield rates and discharge rates from the site should not increase downstream flood risk.
- SuDS design must follow Kent County Council policy, meet the Defra National Non-Statutory Technical Standards, and follow current best practice (CIRIA C752 Manual 2015).

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

	Town Centre North East

		51°26′35″N , 000°13′13″E
		4.39
		Commercial and mixed use
		Residential and town centre uses
		More Vulnerable and less vulnerable
		 • The topography of the western parcel generally slopes towards the north and east of the site. • The central and eastern parcel are divided by the River Darent and lie on the west and east bank respectively. • The topography of the central parcel generally slopes towards the centre of the site. The highest elevation can be seen at the northern end of the site with an additional raised patch of land towards the middle. • The topography of the eastern parcel generally slopes towards the south-west corner of the site. • There are existing buildings located on all three parcels of land which may have affected the LIDAR filtering.
		The River Darent flows between the central and eastern parcels of land

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Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

Site name	Town Centre North East

		The Environment Agency's recorded flood outlines dataset indicates that the western parcel of land flooded as a result of the event that occurred in September 1968 due to the channel capacity of the River Darent being exceeded. The central and eastern parcel of land has not flooded previously. Kent County Council may hold additional records which are not available at this time. These records detail historical flood incidents from all sources, whereas the Environment Agency dataset only records incidents of fluvial, tidal or coastal flooding. The Lead Local Flood Authority should be contacted to obtain further details.		
		1%	2%	64%
		Available modelled data: The site is covered by the 2019 Darent and Cray (fluvial) Flood Modeller-TUFLOW model and the 2019 North Kent Coast (tidal) tidal Flood Modeller-TUFLOW model. The extent of the Flood Zones predicted by the flood models are different to the extent of the actual flood risk, as there are flood risk management features that change the risk. **Flood characteristics:** The large majority of the three parcels of land are within Flood Zone 3a and Flood Zone 2, though when flood risk management features are accounted for in the defended scenario (due to the presence of defences along the River Darent), the flood risk is reduced significantly. Small areas of the site along the River Darent (1% of the site) are within the 5% AEP fluvial flood extent. There is a small increase of 1% for the 1% AEP fluvial flood event. During the fluvial 0.1% AEP event, the defences to the western and the central parcel are predicted to be exceeded and the entire western parcel and a large majority of the central parcel is expected to be inundated, though the eastern parcel is not within the modelled flood extents. When the Dartford Barrier is closed there is a negligible risk of tidal flooding to the site. The site is also at a negligible risk of tidal flooding due to the presence of the Thames tidal flood defences to the north of the site.		
		7%	15%	35%

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

Site name	Town Centre North East

		Description of surface water flow paths: Surface water flooding is predicted along Suffolk Road, Home Gardens and Overy Street during the 3.33% AEP event. During the 1% AEP event, there is an increase in area predicted to be impacted, particularly at the northern ends of the western and eastern parcels. There is over double the area predicted to be affected for the 0.1% AEP event, where further surface water flows are predicted to accumulate across the northern area of the western parcel, the low area of land in the central parcel, and across the eastern parcel. There is also the expansion of surface water flooding on Suffolk Road, Home Gardens and Overy Street during the 0.1% AEP event. RoFSW takes account of building footprints so the flood risk may be affected by existing buildings on the site. It also only considers flood risk where the hazard rating is greater than 0.575. It should be noted that this dataset does not account for tide locking which could exacerbate the surface water risk at the site given the proximity of the tidally influenced Thames which could influence levels within the River Darent. Although the Dartford Barrier is located on the River Darent, risk is dependent on the operation of the barrier. The barrier shuts during extreme tidal levels in the River Thames.
		The Areas Susceptible to Groundwater Flooding (AStGWF) dataset shows the site is located within a 1km grid square where >=25% to <50% of the 1km grid is considered to be susceptible to ground water flooding. The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.
		The Environment Agency Risk of Flooding from Reservoirs dataset does not show the site to be at risk of reservoir flooding.

Site name	Town Centre North East

		High Ground	1% AEP	3
		Concrete Wall	5% AEP	2
		Concrete wall	0.1% AEP	3
		Dartford Barrier and Thames tidal defences	0.1% AEP	-
			There are culverts in proximity of the site which may present a residual risk to the site.	
			The site is not at risk of flooding due to reservoir breach.	
			The Thames tidal defences pose a residual risk to the site in the event of a breach. Modelling was undertaken in 2018 to assess the risk of breach from these defences. Results of this modelling show that most of the western parcel and middle area of the central parcel is at risk of flooding during the present day 0.5% and 0.1% AEP events (16% and 29% of the entire site respectively). The eastern parcel is not predicted to be impacted in the present day events. In the future, the large majority of both the western and central parcels are predicted to be impacted. 52% and 58% of the entire site are predicted to be at risk for the 0.5% AEP (2115 Upper End) and 0.1% AEP (2115 Upper End) respectively.	
			The site also benefits from flood risk management infrastructure along the River Darent. The extent of the undefended 0.1% AEP event indicates that the entire site has the potential to be at risk during a breach.	
		The site is situated within the River Darent at Dartford Trade Park, Brooklands and Dartford to the Thames estuary (064FWF7Dartford) and the Dartford, Crayford and Greenhithe (064FWT1Dartford) Flood Warning Areas. The site is also situated within the River Darent from Westerham to Dartford (064WAF7Darent) and the Coast from Dartford to Allhallows (064WAT1ThamesEst) Flood Alert Areas.		

Site name	Town Centre North East

		Safe access and egress is available for each land parcels via the southern site boundaries for all surface water events. Dry access and egress is available to all three land parcels for the 5% and 1% AEP fluvial events. For the 0.1% AEP fluvial event, dry access and egress can only be available to the eastern land parcel via Overy Street. Wet access and egress could be available to the central and west land parcels via the south site boundaries for the 0.1% AEP fluvial event. During this event, the access route has a hazard rating of 0.5 – 0.75. This hazard is classified as 'Very low hazard' and is considered safe for access and egress.

Thames			
2%	37%	54%	

		The western and the southern half of the central parcel is predicted to be at risk of fluvial flooding during the 1% AEP plus 35% and 70% climate change events. However, due to the presence of flood risk management features, the eastern parcel is not predicted to be at risk of fluvial flooding during the climate change events. The site is affected by flood risk both under existing conditions and in the future. A commitment will be required to measures so that development is safe, and third parties are not adversely affected by proposals. This could potentially be achieved by provision of wider strategic measures, site specific measures, or a combination of these.

15%	21%	24%

	There are small increases in flood extent predicted to occur during the 1% AEP surface water event 20% and 40% climate change events. The areas of increase are located in proximity of Home Gardens roundabout for the northern part of the western parcel, the middle area of the central parcel, and the northern area of the eastern parcel. However, the extents do not reach that of the 0.1% AEP event. Therefore, the site is predicted to be at an increased risk in the future.

Site name	Town Centre North East

		The entire site's bedrock geology consists of White Chalk.
		The western parcel is entirely overlain by alluvium (clay, silt, and sand). The northern part of the central parcel is overlain by undifferentiated river terrace deposits. The southern half of the central parcel and the entire eastern parcel has no recorded geological deposits.
		The parcels are overlain by loamy and clayey floodplain or coastal flat soils with naturally high groundwater
		The whole eastern parcel; the southern half of the central parcel; and the south-eastern third of the western parcel is located in Groundwater Source Protection Zone 1.
		There is a historic landfill site located 1.04km north-east of the eastern parcel.

	Broad scale assessment of possible SuDS	Implementation of SuDS at the site could provide opportunities to deliver multiple benefits including volume control, water quality, amenity and biodiversity. This could provide wider sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. British Geological Society (BGS) data indicates that the underlying geology is the White Chalk subgroup, though the soils at the site are loamy and clayey with high groundwater levels. Groundwater levels and the permeability of soils at the site should be assessed via an infiltration test, with the use of infiltration maximised as much as possible. Off-site discharge in accordance with the SuDS hierarchy may be required to discharge surface water runoff from the site. The entire eastern parcel site is located within Groundwater Source Protection Zone 1 (SPZ), with the central and western parcels partially located within SPZ 1. Kent County Council and the Environment Agency have confirmed that only infiltration from clean roof drainage will potentially be permitted in SPZ1, with appropriate measures in place. Groundwater ingress could potentially impact the hydraulic capacity and structural integrity of detention and attenuation features, if measures to prevent this are not implemented in the design of the surface water drainage system. Given the high-density nature of the site, use of urban SuDS is recommended. Urban sites should not preclude the use of SuDS. It may be possible to reduce site runoff by maximising the permeable surfaces on site using a combination of permeable surfacing and soft landscaping techniques. Mapping suggests that the site slopes make it possible to consider most forms of dentition. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. However, when assessing suitable SuDS, consideration should be given to the location of SPZ1 at the site as discussed above. The potential to utilise conveyance features such as swales to intercept and convey surface water runoff should be considered. Conveyance features should be located on common land or public open space to facilitate ease of access. Where slopes are >5%, features should follow contours or utilise check dams to slow flows. Overland flows paths are present at the development site along highways and in the middle of the central parcel. Where possible opportunities to incorporate these flow paths into the site layout should be considered. If it is proposed to discharge runoff to the River Darent or sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and discharge rate agreed with the asset owner. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA. Surface water outfalls that discharge into the River Darent may be affected by tide locking due to water levels in the River Darent. The impacts of tide locking/flood flows will need to be considered in terms of the attenuation storage requirements of the site. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints.

Site name	Town Centre North East

The site is located within a catchment with a high sensitivity to development. The site is potentially affected by cumulative effects from proposed development upstream and could potentially contribute to a small increase in volumes downstream. The Flood Risk Assessment should thus consider wider catchment implications of proposals. The potential changes to fluvial flood storage volumes should also be addressed, if these are affected by measures to make development safe at the site.

3%	**9%**	**87%**	**1%**

The Sequential Test must be satisfied based on fluvial and other sources of flood risk before the Exception test is applied.

The Exception test will be required in the following scenario:

- highly vulnerable and in flood zone 2
- essential infrastructure in flood zone 3a or 3b
- more vulnerable in flood zone 3a

Development will not be permitted for the following scenario:

- Highly vulnerable development within FZ3a.
- Highly vulnerable, More vulnerable and / or Less vulnerable development within FZ3b.

Flood risk assessment

- At the planning application stage, a site-specific flood risk assessment will be required for this site as it is greater than 1ha in size, it is located within Flood Zone 2 and 3 and may be subject to other sources of flooding where the development would introduce a more vulnerable use and contains land identified in the strategic flood risk assessment as being at increased flood risk in the future. It is also required where development:
  - Is on land which has been identified by the Environment Agency as having critical drainage problems; or
  - Other sources of flooding must be considered as part of any site-specific flood risk assessment, including surface water and groundwater.
  - Consideration should be given to the potential effects of climate change, particularly with respect to surface water. Proposals should consider the opportunity to include measures that provide for a reduction in predicted surface water flood risk at existing development.
  - Breach modelling should be undertaken on the River Darent as the watercourse benefits from flood risk management infrastructure.
  - Climate change modelling should be undertaken using the relevant allowances for the type of development and level of risk.
  - Where there is a reasonable likelihood of multiple sources of flood risk having significant impact, it is recommended that consideration is given to assessing the combined risks of these.
  - Consultation with the Local Authority, Lead Local Flood Authority and Environment Agency should be undertaken at an early stage.
  - Proposals will need to demonstrate that the site can adopt a sequential approach with more vulnerable uses located within lower risk parts of the site where possible.
  - Consideration must be given to the flood risk management measures and commitments required to make development safe over the intended lifetime.

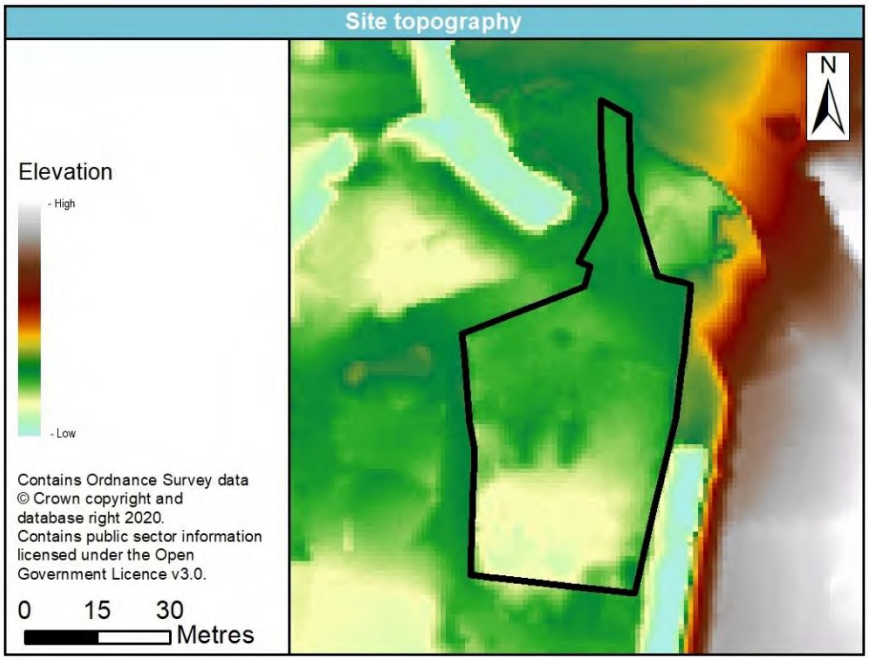
Site name	Town Centre North East

- Cumulative effects should be considered (see above).

Guidance for site design and making development safe:

- New development must seek opportunities to reduce the overall level of flood risk at the site. For example, by:
  - Reducing volume and rate of runoff
  - Relocating development to zones with lower flood risk
  - Creating space for flooding.
- Safe access and egress should be demonstrated in the fluvial plus climate change events. Consideration should also be given to providing safe access and egress during surface water events.
- The Environment Agency has confirmed that more vulnerable uses should be set above the climate change flood level with a freeboard allowance, and developments should not displace water or block flow routes. Detailed proposals for the site will need to be developed in consultation with the Environment Agency.
- All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post development runoff.
- Ground investigations at the site should be undertaken to confirm groundwater levels and the permeability of soils to support the design of SUDS features.
- SuDS should be designed to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc.
- Example features include swales, attenuation features, green roofs, rainwater capture and reuse and permeable paving.
- Assessment of runoff should include allowances for climate change effects.
- Efforts should be made to limit runoff to greenfield rates and discharge rates from the site should not increase downstream flood risk.
- SuDS design must follow Kent County Council policy, meet the Defra National Non-Statutory Technical Standards, and follow current best practice (CIRIA C752 Manual 2015).
- According to the Environment Agency, development should seek to leave an undeveloped margin of 8m next to fluvial watercourses and 16m next to tidal watercourses. Any development within 8m either side of a Main River or within 16m from the foot of any sea defence may require the separate consent of the Environment Agency under local land drainage byelaws.

	The Vicarage, Overy Liberty

		51°26′35″N , 000°13′13″E
		0.27
		Residential
		Residential
		More Vulnerable
		 • The topography of the slope is generally flat. The south-west corner of the site is lowest in elevation • The ground slope across the site generally has a gradient of less than 5%
		The Darent and Cray (Main River) flows through the site.

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Site name	The Vicarage, Overy Liberty

		The entire site is reported to have flooded which occurred in 1968 as a result of channel capacity exceedance and no raised defences.
		0% | 81% | 99%
		Available modelled data: The site is covered by the Environment Agency Darent and Cray (Fluvial) 2019 Flood Modeller-TUFLOW model and the Environment Agency North Kent Coast (Tidal) 2019 Flood Modeller-TUFLOW model. The extent of the Flood Zones predicted by the flood model are very similar to the extent of the actual flood risk at the site. **Flood characteristics:** The site is at a negligible risk of fluvial flooding for the 5% AEP flood event. For the 1% AEP event, 81% of the site is intersected. The north east corner of the site remains to be at negligible risk. For the 0.1% AEP event, there is an increase in flood extent with 99% of the site intersected by this flood extent. When the Dartford Barrier is closed there is a negligible risk of tidal flooding to the site, though in the North Kent Coast undefended scenario the site is only predicted to be impacted by tidal flooding during the 0.1% AEP event.
		12% | 14% | 76%
		Description of surface water flow paths: Surface water accumulation occurs predominantly on the Overy Liberty road to the north of the site and along the Darent and Cray watercourse for the 3.3% AEP event. An increase of 2% occurs for the 1% AEP event. There is a significant increase for the 0.1% AEP event where three quarters of the site is at risk from surface water flooding where there is further expansion and development of flow routes through the site. RoFSW takes into account of building footprints so the flood risk may be affected by existing buildings on the site. It also only considers flood risk where the hazard rating is greater than 0.575. It should be noted that this dataset does not account for fluvial "locking" during periods of high river flows and levels of any outfalls discharging to the Darent which could exacerbate the surface water risk at the site.
		The Areas Susceptible to Groundwater Flooding dataset shows the site is located within a 1km grid square where between 25-50% of the 1km grid is considered to be susceptible to ground water flooding. The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.
		The Environment Agency Risk of Flooding from Reservoirs dataset does not show the site to be at risk of reservoir flooding.

Site name	The Vicarage, Overy Liberty

		High Ground	5%-1% AEP	2-3
		Earth Embankment	2%-1% AEP	2-3
			There are numerous culverts in proximity of the site which could present a residual risk in the event of a blockage.	
			The site is not at risk of flooding due to reservoir breach.	
			Modelling was undertaken in 2018 to assess the residual risk from a breach in the Thames tidal defences. Results of the modelling show that the site is not intersected by present day extents. The site is also predicted to not be impacted by climate change in the future (2115 Upper End). The site is therefore predicted to not be impacted by a breach of the Thames tidal flood defences.	
			The site benefits from flood risk management infrastructure along the River Darent. Breach modelling was undertaken at the Dartford Industrial Park/ Priory Road (Left Bank) for the 0.5% AEP (present day and Upper End EPOCH). Results show that the site is not at risk from this breach location. However, as there are flood risk management infrastructures along the Darent and Cray river, the site could be at risk from defence breach or overtopping.	
		The site is situated within the River Darent at Dartford Trade Park, Brooklands and Dartford to the Thames estuary (064FWF7Dartford) and the Dartford, Crayford and Greenhithe (064FWT1Dartford) Flood Warning Areas. The site is situated within the River Darent from Westerham to Dartford (064WAF7Darent) and the Coast from Dartford to Allhallows (064WAT1ThamesEst) Flood Alert Areas.		
		Dry safe access and egress may be available to the north-east via the access road leading to the A226 for the 5% and 1% AEP fluvial flood event. Wet access and egress could be available via an unnamed access road to the west and north of the site. During this event, the access route has a hazard rating of 0.5 – 0.75. This hazard is classified as 'Very low hazard' and is considered safe for access and egress. Dry safe access and egress is available for the site in the south west via an unnamed road for the 3.33% and 1% AEP surface water events. . However, wet access and egress could be available via the same route for the 0.1% AEP surface water event. During this event, the access route has a hazard rating of 0.75-1.25. This hazard is classified as 'danger for some', generally placing only the most vulnerable people in danger when walking through floodwater.		
		Thames	n/a	35% increase in peak river flows	70% increase in peak river flows

Site name	The Vicarage, Overy Liberty

			81%	98%	98
		There is an increase in extent for all climate change allowances in comparison to the present day 1% AEP flood extent. The southern area of the site is at most risk from fluvial climate change flooding with the northern area becoming more at risk with an increase in climate change. The flood extent for the Upper End (+70%) scenario does not reach that of the 0.1% AEP flood extent. Therefore, the site will be at a slightly higher risk from fluvial flooding in the future. The site is substantially affected by flood risk both under existing conditions and in the future. A commitment will be required to measures so that development is safe and third parties are not adversely affected by proposals. Without evidence that this could potentially be achieved by provision of wider strategic measures, site specific measures, or a combination of these the principle of development is not supported at this site.			
		14%	14%	32%	
		Slight increases in flood extent during the 1% AEP surface water event is predicted for the plus 20% climate change event with flooding being concentrated at the northern end of the site where it intersects the main A226 and the Darent and Cray watercourse. There is a significant increase in extent for the plus 40% climate change event with a large area in the south-west corner of the site predicted to flood. However, the extents do not reach that of the 0.1% AEP event. The site will therefore be at a slightly higher risk from surface water flooding in the future.			

Site name	The Vicarage, Overy Liberty

		The entire site's bedrock geology consists of White Chalk.
		The entire site if overlain by alluvium (clay, silt and sand)
		The site is overlain by freely draining slightly acid but base-rich soils.
		The site is located within Groundwater Source Protection Zone 1 (Inner Zone).
		There is a historic landfill site located 1.12km north-east of the site.

Site name	The Vicarage, Overy Liberty

		Implementation of SuDS at the site could provide opportunities to deliver multiple benefits including volume control, water quality, amenity and biodiversity. This could provide wider sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. British Geological Society (BGS) data indicates that the underlying geology is the White Chalk subgroup, and the soils at the site are likely to be freely draining. Groundwater levels and the permeability of soils at the site should be assessed via an infiltration test, with the use of infiltration maximised as much as possible. Off-site discharge in accordance with the SuDS hierarchy may be required to discharge surface water runoff from the site. The entire site is located within Groundwater Source Protection Zone 1 (SPZ). Kent County Council and the Environment Agency have confirmed that only infiltration from clean roof drainage will be potentially permitted in SPZ1, with appropriate measures in place. Groundwater ingress could potentially impact the hydraulic capacity and structural integrity of detention and attenuation features, if measures to prevent this are not implemented in the design of the surface water drainage system. Given the high-density nature of the site, use of urban SuDS is recommended. Urban sites should not preclude the use of SuDS. It may be possible to reduce site runoff by maximising the permeable surfaces on site using a combination of permeable surfacing and soft landscaping techniques. Mapping suggests that the site slopes make it possible to consider most forms of dentition. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. The potential to utilise conveyance features such as swales to intercept and convey surface water runoff should be considered. Conveyance features should be located on common land or public open space to facilitate ease of access. Where slopes are >5%, features should follow contours or utilise check dams to slow flows. Overland flows paths are present at the development site along highways and in the centre of the site. Where possible opportunities to incorporate these flow paths into the site layout should be considered. If it is proposed to discharge runoff to the River Darent or sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and discharge rate agreed with the asset owner. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints.

Site name	The Vicarage, Overy Liberty

		The site is located within a catchment with a high sensitivity to development. The site is potentially affected by cumulative effects from proposed development upstream and could potentially contribute to a small increase in volumes downstream. The Flood Risk Assessment should thus consider wider catchment implications of proposals. The potential changes to fluvial flood storage volumes should also be addressed, if these are affected by measures to make development safe at the site.

	0%	**16%**	**84%**	**0%**

The Sequential Test must be satisfied based on fluvial and other sources of flood risk before the Exception test is applied.

The Exception test will be required in the following scenario:

- highly vulnerable and in flood zone 2
- essential infrastructure in flood zone 3a or 3b
- more vulnerable in flood zone 3a

Development will not be permitted for the following scenario:

- Highly vulnerable development within FZ3a.
- Highly vulnerable, More vulnerable and / or Less vulnerable development within FZ3b.

Flood risk assessment

- At the planning application stage, a site-specific flood risk assessment will be required for this site as it is located within Flood Zone 2 and 3 and may be subject to other sources of flooding where the development would introduce a more vulnerable use and contains land identified in the strategic flood risk assessment as being at increased flood risk in the future. It is also required where development:
  - Is on land which has been identified by the Environment Agency as having critical drainage problems; or
  - Other sources of flooding must be considered as part of any site-specific flood risk assessment, including surface water and groundwater.
  - Consideration should be given to the potential effects of climate change, particularly with respect to surface water. Proposals should consider the opportunity to include measures that provide for a reduction in predicted surface water flood risk at existing development.
  - Breach modelling should be undertaken on the River Darent as the watercourse benefits from flood risk management infrastructure.
  - Climate change modelling should be undertaken using the relevant allowances for the type of development and level of risk.
  - Where there is a reasonable likelihood of multiple sources of flood risk having significant impact, it is recommended that consideration is given to assessing the combined risks of these.
  - Consultation with the Local Authority, Lead Local Flood Authority and Environment Agency should be undertaken at an early stage.
  - Proposals will need to demonstrate that the site can adopt a sequential approach with more vulnerable uses located within lower risk parts of the site where possible.
  - Consideration must be given to the flood risk management measures and commitments required to make development safe over the intended lifetime.

Site name	The Vicarage, Overy Liberty

- Cumulative effects should be considered (see above).

Guidance for site design and making development safe:

- New development must seek opportunities to reduce the overall level of flood risk at the site. For example, by:
  - Reducing volume and rate of runoff
  - Relocating development to zones with lower flood risk
  - Creating space for flooding.
- Safe access and egress should be demonstrated in the surface water 1% AEP plus climate change event.
- The Environment Agency has confirmed that more vulnerable uses should be set above the climate change flood level with a freeboard allowance, and developments should not displace water or block flow routes. Detailed proposals for the site will need to be developed in consultation with the Environment Agency.
- All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post development runoff.
- A greenfield site such as this should be able to implement an exemplar surface water drainage scheme to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc.
- Example features include swales, attenuation features, green roofs, rainwater capture and reuse and permeable paving.
- Assessment of runoff should include allowances for climate change effects.
- Efforts should be made to limit runoff to greenfield rates and discharge rates from the site should not increase downstream flood risk.
- According to the Environment Agency, development should seek to leave an undeveloped margin of 8m next to fluvial watercourses and 16m next to tidal watercourses. Any development within 8m either side of a Main River or within 16m from the foot of any sea defence may require the separate consent of the Environment Agency under local land drainage byelaws.

	Glentworth Club

		554146 E, 173590 N
		0.66
		Commercial
		Residential
		More Vulnerable
		 • The topography of the site slopes from west to east. • The ground slope across the site generally has a gradient of less than 5%. • There is an existing building located on the north east corner of the site.
		The Darent and Cray (Main River) is located 190m to the north-east of the site.

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Site name	Glentworth Club

A small segment to the east of the site is reported to have flooded in 1968 as a result of channel capacity exceedance and no raised defences.

Kent County Council may hold additional records which are not available at this time. These records detail historical flood incidents from all sources, whereas the Environment Agency dataset only records incidents of fluvial, tidal or coastal flooding. The Lead Local Flood Authority should be contacted to obtain further details.

0%	0%	61%

Available modelled data:
The site is covered by the Environment Agency Darent and Cray (Fluvial) 2019 Flood Modeller-TUFLOW model. The extent of the Flood Zones predicted by the flood model are very similar to the extent of the actual flood risk at the site.

Flood characteristics:
The site is at a negligible risk from the 5% and 1% AEP fluvial events and all modelled tidal events. The eastern half of the site is within the 0.1% AEP fluvial flood event.

3%	13%	14%

Description of surface water flow paths:
Surface water accumulation occurs on the A225 road adjacent to the west side of the site as well as in the north-east corner for the 3.3% AEP event. There is an increase of 10% in flood extent for the 1% AEP event where there is further development of flooding in the north-east corner as well as in the south-east corner. There is a further 1% increase in flood extent at the site for the 0.1% AEP event with the formation of a flow route from the A225 through the site.
RoFSW takes into account of building footprints so the flood risk may be affected by existing buildings on the site. It also only considers flood risk where the hazard rating is greater than 0.575.

It should be noted that this dataset does not account for fluvial "locking" during periods of high river flows and levels of any outfalls discharging to the Darent which could exacerbate the surface water risk at the site.

The Areas Susceptible to Groundwater Flooding (AStGWF) dataset shows the site is located within a 1km grid square where between 25-50% of the 1km grid is considered to be susceptible to ground water flooding.

The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

Site name	Glentworth Club

		The Environment Agency Risk of Flooding from Reservoirs dataset does not show the site to be at risk of reservoir flooding.		
		High Ground	2%-1.3% AEP	3
		Earth Embankment	2% AEP	3
			There are no culverts located within the site which could present a residual risk in the event of a blockage	
			The site is not at risk of flooding due to reservoir breach	
			Modelling was undertaken in 2018 to assess the residual risk from a breach in the River Thames tidal defences. Results of the modelling show that the site is not intersected by present day extents. The site is also predicted to not be impacted by climate change in the future (2115 Upper End). The site is therefore predicted to be not at risk from breach of the River Thames tidal flood defences.	
			The site benefits partially from flood risk management infrastructure along the River Darent. Breach modelling was undertaken at the Dartford Industrial Park/ Priory Road (Left Bank) for the 0.5% AEP (present day and 2115 Upper End). Results show that the site is not at risk from this breach location. However, as there are flood risk management infrastructures along the Darent and Cray river, the site could be at risk from defence breach or overtopping.	
		The site is situated within the River Darent at Dartford Trade Park, Brooklands and Dartford to the Thames estuary (064FWF7Dartford) Flood Warning Areaa. The site is also situated within the River Darent from Westerham to Dartford (064WAF7Darent) Flood Alert Area.		
		Safe access and egress for the western half of the site may be available during all surface water events and the 5% and 1% AEP fluvial flood events via the main A225 Lowfield Street road. However, safe access and egress for the eastern area of the site may not be available during the 0.1% AEP flood event or during the 1% AEP plus 35% or 70% climate change fluvial events given large parts of the site and the surrounding land is predicted to be at risk of flooding. Additionally, access and egress routes for the western half of the site may need to account for surface water flooding along the A225.		
		Thames		

Site name	Glentworth Club

			3%	33%	52%
		There is an increase in extent for all climate change allowances in comparison to the present day 1% AEP flood extent. The eastern area of the site is predicted to be most susceptible to fluvial risk in the future. The flood extent for the Upper End (+70%) scenario does not reach that of the 0.1% AEP flood extent. The site will therefore be at higher risk from fluvial flooding in the future. The potential change should be considered in the preparation of detailed proposals and assessed in an FRA. A sequential approach should be adopted to the layout and design at the site. The site is affected by flood risk both under existing conditions and in the future. A commitment will be required to measures so that development is safe and third parties are not adversely affected by proposals. This could potentially be achieved by provision of wider strategic measures, site specific measures, or a combination of these.		
		13%	16%	20%	
		There is a slight increase in flood extent during the 1% AEP surface water event for the plus 20% and 40% climate change scenarios. These increases are located towards the north-east and south-east corners of the site. However, the extents do not reach that of the 0.1% AEP event. The site will therefore be at a slightly higher risk from surface water flooding in the future. The implications of the predicted changes should be addressed in an FRA and appropriate provisions incorporated in the design and layout.		

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

Site name	Glentworth Club

		The entire site's bedrock geology consists of White Chalk.
		The entire site's is overlain by alluvium (clay, silt, and sand).
		The parcels are overlain by loamy and clayey floodplain or coastal flat soils with naturally high groundwater
		The eastern parcel of the site is located within Ground Water Source Protection Zone 2 (Outer Zone)
		There is a historic landfill site located 716 metres south-east of the site.

Site name	Glentworth Club

		Implementation of SuDS at the site could provide opportunities to deliver multiple benefits including volume control, water quality, amenity and biodiversity. This could provide wider sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. British Geological Society (BGS) data indicates that the underlying geology is the White Chalk subgroup, though the soils at the site are loamy and clayey with high groundwater levels. Groundwater levels and the permeability of soils at the site should be assessed via an infiltration test, with the use of infiltration maximised as much as possible. Off-site discharge in accordance with the SuDS hierarchy may be required to discharge surface water runoff from the site. The eastern part of the site is located within Groundwater Source Protection Zone 2 (SPZ). Kent County Council and the Environment Agency have confirmed that in GSPZ 2, infiltration is potentially possible for surface run-off from roads, car parking and public or amenity provided the SUDS management train is used to treat the drainage. Groundwater ingress could potentially impact the hydraulic capacity and structural integrity of detention and attenuation features, if measures to prevent this are not implemented in the design of the surface water drainage system. Given the location of the site being in close proximity to the Darent and Cray river, the use of SuDS is recommended. It may be possible to reduce site runoff by maximising the permeable surfaces on site using a combination of permeable surfacing and soft landscaping techniques. Mapping suggests that the site slopes make it possible to consider most forms of dentition. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. The potential to utilise conveyance features such as swales to intercept and convey surface water runoff should be considered. Conveyance features should be located on common land or public open space to facilitate ease of access. Where slopes are >5%, features should follow contours or utilise check dams to slow flows. If it is proposed to discharge runoff to the Darent and Cray river, local drainage network or sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and discharge rate agreed with the asset owner. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints

Site name	Glentworth Club

		The site is located within a catchment with a high sensitivity to development. The Implications of increased volumes from proposed development should be addressed at an appropriate catchment level to demonstrate that additional volumes do not exacerbate flood risk at vulnerable locations remote from the site. This wider assessment should include consideration of other proposed development within the catchments(s).

38%	**62%**	**0%**	**0%**

The Sequential Test must be satisfied based on fluvial and other sources of flood risk before the Exception test is applied.

The Exception test will be required in the following scenario:

- highly vulnerable and in flood zone 2
- essential infrastructure in flood zone 3a or 3b
- more vulnerable in flood zone 3a

Development will not be permitted for the following scenario:

- Highly vulnerable development within FZ3a.
- Highly vulnerable, More vulnerable and / or Less vulnerable development within FZ3b.

Flood Risk Assessment

- At the planning application stage, a site-specific flood risk assessment will be required for this site as it is located within Flood Zone 2, if more than 10 dwellings are proposed and may be subject to other sources of flooding where the development would introduce a more vulnerable use and contains land identified in the strategic flood risk assessment as being at increased flood risk in the future. It is also required where development:
    - Is on land which has been identified by the Environment Agency as having critical drainage problems; or
    - Other sources of flooding must be considered as part of any site-specific flood risk assessment, including surface water and groundwater.
    - Consideration should be given to the risk of fluvial flooding associated with the drainage ditches located to the west and east of the site.
    - Consideration should be given to the potential effects of climate change, particularly with respect to surface water. Proposals should consider the opportunity to include measures that provide for a reduction in predicted surface water flood risk at existing development.
    - Breach modelling should be undertaken on the River Darent as the watercourse benefits from flood risk management infrastructure.
    - Climate change modelling should be undertaken using the relevant allowances for the type of development and level of risk.
    - Where there is a reasonable likelihood of multiple sources of flood risk having significant impact, it is recommended that consideration is given to assessing the combined risks of these.
    - Consultation with the Local Authority, Lead Local Flood Authority and Environment Agency should be undertaken at an early stage.
    - Consideration must be given to the flood risk management measures and commitments required to make development safe over the intended lifetime.

Site name	Glentworth Club

- Cumulative effects should be considered (see above).
- Proposals will need to demonstrate that the site can adopt a sequential approach with more vulnerable uses located outside Flood Zone 3a and 2 where possible.

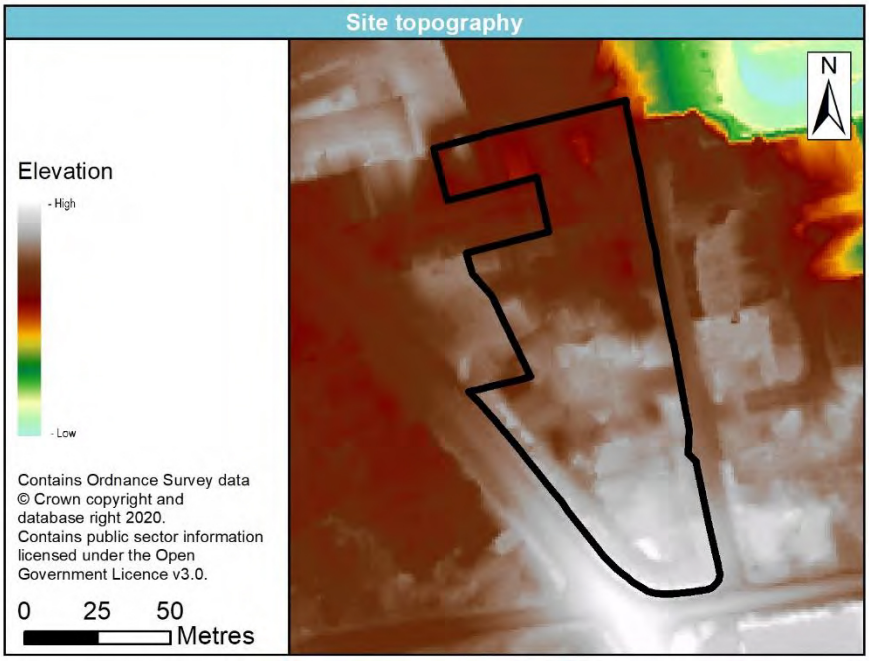
Guidance for site design and making development safe:

- New development must seek opportunities to reduce the overall level of flood risk at the site. For example, by:
  - Reducing volume and rate of runoff
  - Relocating development to zones with lower flood risk
  - Creating space for flooding.
- Safe access and egress should be demonstrated in the fluvial and tidal plus climate change events. Consideration should also be given to providing safe access and egress during surface water events.
- The Environment Agency has confirmed that more vulnerable uses should be set above the climate change flood level with a freeboard allowance, and developments should not displace water or block flow routes. Detailed proposals for the site will need to be developed in consultation with the Environment Agency.All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post development runoff.
- Ground investigations at the site should be undertaken to confirm groundwater levels and the permeability of soils to support the design of SUDS features.
- SuDS should be designed to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc.
- Example features include swales, attenuation features, green roofs, rainwater capture and reuse and permeable paving.
- Assessment of runoff should include allowances for climate change effects.
- Efforts should be made to limit runoff to greenfield rates and discharge rates from the site should not increase downstream flood risk.
- SuDS design must follow Kent County Council policy, meet the Defra National Non-Statutory Technical Standards, and follow current best practice (CIRIA C752 Manual 2015).

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

	Burnham Trading Estate

		553557 E, 175153 N
		0.87
		Industrial
		Retained as industrial or residential / commercial
		Less vulnerable / More vulnerable
		 • Ground levels at the site slope from the high point by Lawson Road in the south of the site to an area of lower elevations in the north. • There are several existing buildings located across the site. • The ground slope across the site generally has a gradient of less than 5%.
		The River Darent is located 215m east of the site and the Stanham River is located 300m west of the site.

Site name	Burnham Trading Estate

The Environment Agency's recorded flood outlines dataset does not indicate that flooding has been recorded at the site.

Kent County Council may hold additional records which are not available at this time. These records detail historical flood incidents from all sources, whereas the Environment Agency dataset only records incidents of fluvial, tidal or coastal flooding. The Lead Local Flood Authority should be contacted to obtain further details.

0%	0%	0%

Available modelled data:
The site is covered by the 2019 Darent and Cray (fluvial), 2020 Dartford and Crayford (fluvial) and 2018 North Kent Coast Flood Modeller-TUFLOW (tidal) models. The extent of the Flood Zones predicted by the flood models are different to the extent of the actual flood risk, as there are flood risk management features that change the risk.

Flood characteristics:
The site is entirely located with Flood Zone 1 and is therefore at negligible risk of fluvial and tidal flooding.

0%	2%	10%

Description of surface water flow paths:
Surface water flooding is not predicted to occur within the site boundary during the 3.33% AEP event. During the 1% AEP event surface water flooding is predicted to occur at the site, with a small area of ponding occurring in the north of the site. In the 0.1% AEP event, 10% of the site is predicted to be at risk of surface water flooding, with small areas of surface water ponding predicted across the site.

RoFSW takes account of building footprints so the flood risk may be affected by existing buildings on the site. It also only considers flood risk where the hazard rating is greater than 0.575.

The Areas Susceptible to Groundwater Flooding (AStGWF) dataset shows the site is located within a 1km grid square where >=50% to <75% of the area is predicted to be at risk of groundwater flooding.

The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist. Ground investigations at the site

Site name	Burnham Trading Estate

		should be used to confirm groundwater levels to support the design of SUDS features.		
		The Environment Agency Risk of Flooding from Reservoirs dataset does not show the site to be at risk of reservoir flooding.		
		N/A	N/A	N/A
			There are no known culverts or structures in the vicinity of the site.	
			The site is not at risk of flooding due to reservoir breach.	
			The site is not at risk of flooding due to defence breach or overtopping.	
		The site is not within a Flood Warning Area or Flood Alert Area.		
		Safe access and egress from the site is likely to be possible during a surface water or fluvial / tidal flood event via Lawson Road, Burnham Road and the road along the site's eastern boundary.		
		Thames		
			0%	0%	0%
		The site is not predicted to be impacted by fluvial or tidal flooding as a result of climate change.		
		2%	3%	5%
		Climate change is predicted to have a small impact on the extent of surface water flooding at the site. Additional areas of surface water ponding are predicted to slightly increase the area of the site expected to flood from 2% (1% AEP present day) to 5% for the 1% AEP plus 40% rainfall uplift.		

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

Site name	Burnham Trading Estate

		The entire site's bedrock geology consists of White Chalk.
		The entire site is covered by alluvium (clay, silt, sand).
		The site is overlain by loamy soils with naturally high groundwater.
		The site is not located within a Groundwater Source Protection Zone.
		There is a historic landfill site located 200m northeast of the eastern parcel.

Site name	Burnham Trading Estate

		Implementation of SuDS at the site could provide opportunities to deliver multiple benefits including volume control, water quality, amenity and biodiversity. This could provide wider sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. British Geological Society (BGS) data indicates that the underlying geology is the White Chalk subgroup, though the soils at the site are loamy and clayey with high groundwater levels. Groundwater levels and the permeability of soils at the site should be assessed via an infiltration test, with the use of infiltration maximised as much as possible. Off-site discharge in accordance with the SuDS hierarchy may be required to discharge surface water runoff from the site. Groundwater ingress could potentially impact the hydraulic capacity and structural integrity of detention and attenuation features, if measures to prevent this are not implemented in the design of the surface water drainage system. Given the high-density nature of the site, use of urban SuDS is recommended. Urban sites should not preclude the use of SuDS. It may be possible to reduce site runoff by maximising the permeable surfaces on site using a combination of permeable surfacing and soft landscaping techniques. Mapping suggests that the site slopes make it possible to consider most forms of dentition. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. The potential to utilise conveyance features such as swales to intercept and convey surface water runoff should be considered. Conveyance features should be located on common land or public open space to facilitate ease of access. Where slopes are >5%, features should follow contours or utilise check dams to slow flows. If it is proposed to discharge runoff to a watercourse or the sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and discharge rate agreed with the asset owner. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints.
		The site is located across a catchment boundary, with the south of the site in a catchment with a high sensitivity to cumulative impacts of development and the north of the site in a catchment with medium sensitivity. The implications of increased volumes from proposed development should be addressed at an appropriate catchment level to demonstrate that additional volumes do not exacerbate flood risk at vulnerable locations remote from the site. This wider assessment should include consideration of other proposed development within the catchments(s).

	100%	**0%**	**0%**	**0%**

Site name	Burnham Trading Estate

The Sequential Test must be satisfied based on fluvial and other sources of flood risk before the Exception test is applied.
The Exception Test is not required as the site is not within Flood Zone 2 or 3 but a Flood Risk Assessment is still required. See below for further details on requirements for a Flood Risk Assessment.

Flood risk assessment

- At the planning application stage, a site-specific flood risk assessment will be required for this site if more than 10 dwellings are proposed for the site. It will also be required if development is:
  - on land which may be subject to other sources of flooding, where the development would introduce a more vulnerable use;
  - on land which has been identified by the Environment Agency as having critical drainage problems; or
  - on land identified in the strategic flood risk assessment as being at increased flood risk in future.
- Other sources of flooding must be considered as part of any site-specific flood risk assessment, including surface water and groundwater.
- Consideration should be given to the potential effects of climate change, particularly with respect to surface water. Proposals should consider the opportunity to include measures that provide for a reduction in the predicted surface water flood risk at existing development.
- Climate change modelling should be undertaken using the relevant allowances for the type of development and level of risk.
- Where there is a reasonable likelihood of multiple sources of flood risk having significant impact in combination it is recommended that consideration is given to assessing the combined risks of these.
- Consultation with the Local Authority, Lead Local Flood Authority and Environment Agency should be undertaken at an early stage.
- Consideration must be given to the flood risk management measures and commitments required to make development safe over the intended lifetime.
- Cumulative effects should be considered (see above)

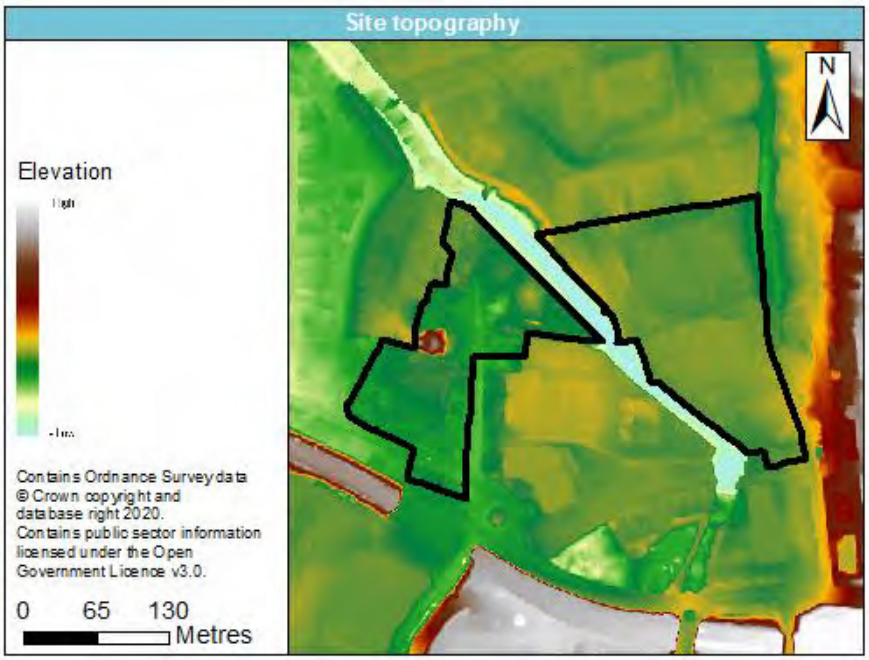
Guidance for site design and making development safe:

- New development must seek opportunities to reduce the overall level of flood risk at the site. For example, by:
  - Reducing volume and rate of runoff
  - Relocating development to zones with lower flood risk
  - Creating space for flooding.
- Safe access and egress should be demonstrated in the surface water plus climate change events.
- All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post development runoff.
- Ground investigations at the site should be undertaken to confirm groundwater levels and the permeability of soils to support the design of SUDS features.
- SuDS should be designed to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc.
- Example features include swales, attenuation features, green roofs, rainwater capture and reuse and permeable paving.
- Assessment of runoff should include allowances for climate change effects.
- Efforts should be made to limit runoff to greenfield rates and discharge rates from the site should not increase downstream flood risk.
- SuDS design must follow Kent County Council policy, meet the Defra National Non-Statutory Technical Standards, and follow current best practice (CIRIA C752 Manual 2015).

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

	Lower Hythe Street and Central Road

		554324 E, 174638 N
		5.03
		Industrial
		Residential
		More Vulnerable
		 • The topography of the western parcel generally slopes towards Hythe Street from the north and west of the site. Ground levels in the eastern parcel slope west to east towards Central Road. • There are existing buildings located on both parcels of land. • There are a number of existing buildings across the site and which have affected localised filtering of the LIDAR data. • The ground slope across the site generally has a gradient of less than 5%.
		The River Darent flows between the two parcels of land.

	Flood history	The Environment Agency's recorded flood outlines dataset indicates that flooding occurred in September 1968 along Victoria Road and Hythe Street due to the channel capacity of the River Darent being exceeded. Kent County Council may hold additional records which are not available at this time. These records detail historical flood incidents from all sources, whereas the Environment Agency dataset only records incidents of fluvial, tidal or coastal flooding. The Lead Local Flood Authority should be contacted to obtain further details.

1%	1%	43%

Available modelled data:
The site is covered by the 2019 Darent and Cray, 2020 Dartford and Crayford and 2018 North Kent Coast Flood Modeller-TUFLOW models. The extent of the Flood Zones predicted by the flood models are different to the extent of the actual flood risk, as there are flood risk management features that change the risk.

Flood characteristics:
The site is entirely located within Flood Zone 3a, although when flood risk management features are accounted for in the defended scenario both parcels of land are partially (<1%) within the modelled flood extents for the fluvial 5% and 1% AEP events. This is due to the presence of defences along the River Darent. During the fluvial 0.1% AEP event, the defences adjacent to the western parcel are predicted to be exceeded and most of the parcel is expected to be inundated, though the eastern parcel is not within the modelled flood extents.

When the Dartford Barrier is closed there is a negligible risk of tidal flooding to the site.

2%	6%	18%

Description of surface water flow paths:
Surface water flooding is predicted along Victoria Road, Hythe Street, and Central Road during the 3.33% AEP event. During the 1% AEP event there is an increase in the area predicted to be impacted, particularly in the eastern parcel where ponding is predicted in the north and a flow path is predicted to form along the southern boundary. There is a further 12% increase for the 0.1% AEP event where further surface water flows are predicted to accumulate adjacent to Central Road in the eastern parcel and to the west of Hythe Street in the western parcel.

RoFSW takes account of building footprints so the flood risk may be affected by existing buildings on the site. It also only considers flood risk where the hazard rating is greater than 0.575.

It should be noted that this dataset does not account for tide locking which could exacerbate the surface water risk at the site given the proximity of the tidally influenced Thames which could influence levels within the River Darent. Although the Dartford Barrier is located on the River Darent, risk is dependent on the operation of the barrier. The barrier shuts during extreme tidal levels in the Thames but a normal high tide occurring at the same time as a surface water event could be worsened by tide locking.

	Groundwater	The Areas Susceptible to Groundwater Flooding (AStGWF) dataset shows the site is located within a 1km grid square where >=25% to <50% of the area is predicted to be at risk of groundwater flooding. The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist. Ground investigations at the site should be used to confirm groundwater levels to support the design of SUDS features.		
		The Environment Agency Risk of Flooding from Reservoirs dataset does not show the site to be at risk of reservoir flooding.		
		High ground (Darent right bank)	1000	3
		Wall (Darent right bank)	1000	2/3
		Wall (Darent left bank)	1000	2/3
		Dartford Barrier and Thames tidal defences	1000	-
			Around 125m southwest of the western parcel there is a culvert linking the Mill Pond to the River Darent.	
			The site is not at risk of flooding due to reservoir breach.	
			The Thames tidal defences pose a residual risk to the site in the event of a breach. Modelling was undertaken in 2018 to assess the risk of breach from these defences. Results of this modelling show that most of the western package is at risk of flooding during the present day 0.5% and 0.1% AEP events, 38% and 44% of the whole site predicted to impacted respectively. Only the southern part of the eastern package is predicted to be impacted in the present day 0.1% AEP event. In the future, the site is predicted increase in risk of 28% for the 0.5% AEP (2115 Upper End) breach event. For the 0.1% AEP (2115 Upper End) breach event, an increase of 35% is precited to occur. The increases in flood extent are predicted to occur across the eastern parcel.	
			The site also benefits from flood risk management infrastructure along the River Darent. The extent of the undefended 1% AEP event indicates that the entire site has the potential to be at risk during a breach.	
		Both packages are located within flood alert areas (064WAF7Darent and 064WAT1ThamesEst) and flood warning areas (064WAF7Darent and 064WAT1ThamesEst) associated with the River Darent and the Thames Estuary.		

	Access and egress	Safe access and egress for the eastern parcel may be available during all surface water and fluvial flood events via Central Road or the industrial land to the north of the site. However, safe access and egress for the western parcel may not be available during a 1% AEP plus 35% or 70% fluvial event given large parts of the site and the surrounding land is predicted to be at risk of flooding. Additionally access and egress routes for the western parcel may need to account for surface water flooding along Hythe Street and Victoria Road.

Thames	n/a	35% increase in peak river flows	70% increase in peak river flows
	1%	31%	41%

	Most of the western parcel is predicted to be at risk of fluvial flooding during the 1% AEP plus 35% and 70% climate change events, despite the site not being predicted to flood during the 1% AEP event. However, due to the presence of flood risk management features, the eastern parcel is not predicted to be at risk of fluvial or tidal flooding during the climate change events. The site is affected by flood risk both under existing conditions and in the future. A commitment will be required to measures so that development is safe, and third parties are not adversely affected by proposals. This could potentially be achieved by provision of wider strategic measures, site specific measures, or a combination of these.

6 %	9%	11%

	Small increases in flood extent during the 1% AEP surface water event are predicted for the plus 20% and 40% climate change events. However, the extents do not reach that of the 0.1% AEP event. These increases area located in the area around Hythe Street in the western parcel and along Central Road in the eastern parcel.
	The entire site's bedrock geology consists of White Chalk.
	The eastern parcel is almost entirely overlain by undifferentiated river terrace deposits, with a small area in the south of the parcel with no deposits recorded. The northeast corner of the western parcel is also overlain by undifferentiated river terrace deposits, but most of the parcel is covered by alluvium (clay, silt, sand).
	The parcels are overlain by loamy and clayey floodplain or coastal flat soils with naturally high groundwater.
	The site is not located within a Groundwater Source Protection Zone.
	There is a historic landfill site located 275m northeast of the eastern parcel.

	Broad scale assessment of possible SuDS	Implementation of SuDS at the site could provide opportunities to deliver multiple benefits including volume control, water quality, amenity and biodiversity. This could provide wider sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. British Geological Society (BGS) data indicates that the underlying geology is the White Chalk subgroup, though the soils at the site are loamy and clayey with high groundwater levels. Groundwater levels and the permeability of soils at the site should be assessed via an infiltration test, with the use of infiltration maximised as much as possible. Off-site discharge in accordance with the SuDS hierarchy may be required to discharge surface water runoff from the site. Groundwater ingress could potentially impact the hydraulic capacity and structural integrity of detention and attenuation features, if measures to prevent this are not implemented in the design of the surface water drainage system. Given the high-density nature of the site, use of urban SuDS is recommended. Urban sites should not preclude the use of SuDS. It may be possible to reduce site runoff by maximising the permeable surfaces on site using a combination of permeable surfacing and soft landscaping techniques. Mapping suggests that the site slopes make it possible to consider most forms of dentition. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. The potential to utilise conveyance features such as swales to intercept and convey surface water runoff should be considered. Conveyance features should be located on common land or public open space to facilitate ease of access. Where slopes are >5%, features should follow contours or utilise check dams to slow flows. Overland flows paths are present at the development site along highways and in the south of the eastern parcel. Where possible opportunities to incorporate these flow paths into the site layout should be considered. If it is proposed to discharge runoff to the River Darent or sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and discharge rate agreed with the asset owner. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA. Surface water outfalls that discharge into the River Darent may be affected by tide locking due to water levels in the River Darent. The impacts of tide locking/flood flows will need to be considered in terms of the attenuation storage requirements of the site. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints.
		The site is located within a catchment with a high sensitivity to cumulative impacts of development. The Implications of increased volumes from proposed development should be addressed at an appropriate catchment level to demonstrate that additional volumes do not exacerbate flood risk at vulnerable locations remote from the site. This wider assessment should include consideration of other proposed development within the catchment.

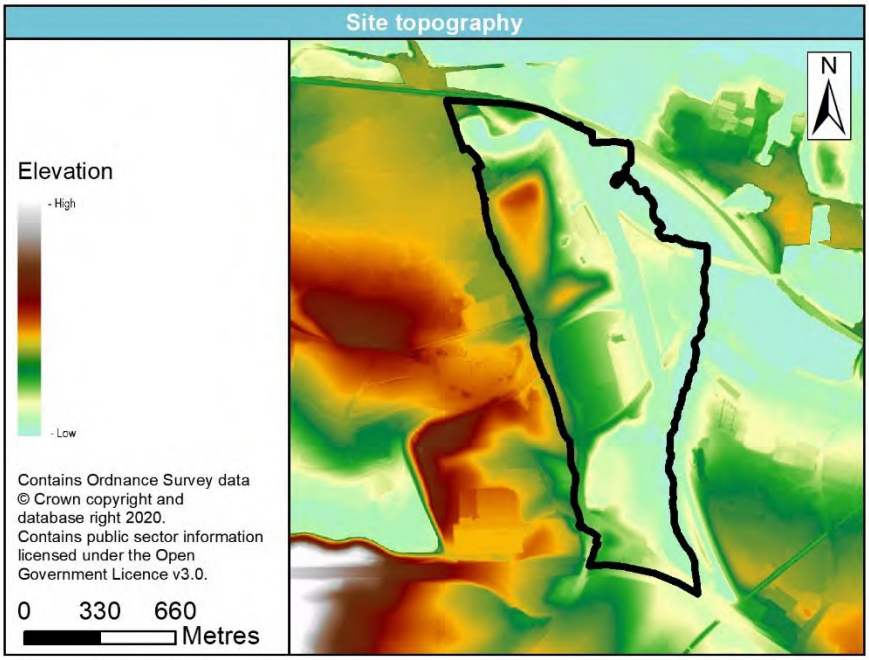
	0%	**0%**	**99%**	**1%**
	The Sequential Test must be satisfied based on fluvial and other sources of flood risk before the Exception test is applied. The Exception test will be required in the following scenario: • highly vulnerable and in flood zone 2 • essential infrastructure in flood zone 3a or 3b • more vulnerable in flood zone 3a Development will not be permitted for the following scenario: • Highly vulnerable development within FZ3a. • Highly vulnerable, More vulnerable and / or Less vulnerable development within FZ3b.			
Recommend-ations for Local Plan policy				
	Flood risk assessment • At the planning application stage, a site-specific flood risk assessment will be required for this site as it is greater than 1ha, located within Flood Zone 3 and may be subject to other sources of flooding where the development would introduce a more vulnerable use and contains land identified in the strategic flood risk assessment as being at increased flood risk in the future. It is also required where development: ○ Is on land which has been identified by the Environment Agency as having critical drainage problems; or ○ Other sources of flooding must be considered as part of any site-specific flood risk assessment, including surface water and groundwater. ○ Consideration should be given to the potential effects of climate change, particularly with respect to surface water. Proposals should consider the opportunity to include measures that provide for a reduction in predicted surface water flood risk at existing development. ○ Climate change modelling should be undertaken using the relevant allowances for the type of development and level of risk. ○ Where there is a reasonable likelihood of multiple sources of flood risk having significant impact, it is recommended that consideration is given to assessing the combined risks of these. ○ Consultation with the Local Authority, Lead Local Flood Authority and Environment Agency should be undertaken at an early stage. ○ Proposals will need to demonstrate that the site can adopt a sequential approach with more vulnerable uses located within lower risk parts of the site where possible. ○ Consideration must be given to the flood risk management measures and commitments required to make development safe over the intended lifetime. ○ Cumulative effects should be considered (see above). **Guidance for site design and making development safe:** • New development must seek opportunities to reduce the overall level of flood risk at the site. For example, by: ○ Reducing volume and rate of runoff ○ Relocating development to zones with lower flood risk ○ Creating space for flooding. • Safe access and egress should be demonstrated in the fluvial plus climate change events. Consideration should also be given to providing safe access and egress during surface water events. • The Environment Agency has confirmed that more vulnerable uses should be set above the climate change flood level with a freeboard allowance, and developments should not displace water or block flow routes. Detailed proposals for the site will need to be developed in consultation with the Environment Agency.			

	• All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post development runoff. • Ground investigations at the site should be undertaken to confirm groundwater levels and the permeability of soils to support the design of SUDS features. • SuDS should be designed to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc. • Example features include swales, attenuation features, green roofs, rainwater capture and reuse and permeable paving. • Assessment of runoff should include allowances for climate change effects. • Efforts should be made to limit runoff to greenfield rates and discharge rates from the site should not increase downstream flood risk. • SuDS design must follow Kent County Council policy, meet the Defra National Non-Statutory Technical Standards, and follow current best practice (CIRIA C752 Manual 2015). • The Environment Agency has confirmed that, both halves of the site border the tidal Darent and works to improve the accessibility, amenity, ecology and flood defences in the river corridor should be incorporated where possible. • According to the Environment Agency, development should seek to leave an undeveloped margin of 8m next to fluvial watercourses and 16m next to tidal watercourses. Any development within 8m either side of a Main River or within 16m from the foot of any sea defence may require the separate consent of the Environment Agency under local land drainage byelaws.

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

	Ebbsfleet Central

		561396 E , 174104 N
		125.13
		Open land, station and car parks.
		Mixed use
		More vulnerable and less vulnerable
		 • The site slopes from west to east with the highest elevations located in the north west corner of the site. • A railway line intersects the site from the north boundary to the south east. • The ground slope across the site generally has a gradient of less than 5%.
		The River Ebbsfleet (Main River) flows from south to north east to the River Thames along the eastern site boundary. The River Thames is located 690m north east of the site. Blue Lake is located 100m east of the site and outfalls into the River Ebbsfleet 50m east of the site.

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

Site name	Ebbsfleet Central

The Environment Agency's Recorded Flood Outline dataset reports no historical incidents to have occurred at the site.

Kent County Council may hold additional records which are not available at this time. These records detail historical flood incidents from all sources, whereas the Environment Agency dataset only records incidents of fluvial, tidal or coastal flooding. Please contact the Lead Local Flood Authority for further details.

3%	4%	4%

Available modelled data:
The site is covered by the Environment Agency North Kent Coast (Tidal) 2019 Flood Modeller-TUFLOW model and River Ebbsfleet (Fluvial) 2015 Flood Modeller-TUFLOW model. The extent of the Flood Zones predicted by the flood model are different to the extent of the actual flood risk, as there are flood risk management features that change the risk.

Flood characteristics:
The east boundary of the site is partially within Flood Zone 3b (5% AEP defended fluvial event). This is further increased by <0.5% for the 1% AEP fluvial event. A further increase of <0.5% is predicted to occur for the 0.1% AEP fluvial event along Thames Way. Risk remains contained to the east of the site along the site boundary,

Due to the presence of tidal flood risk management features to the north of the site, the site is at a negligible risk of flooding from tidal flooding.

2%	4 %	14%

Description of surface water flow paths:
Surface water accumulation occurs in across the centre of the site along the railway line and roads and in the north west and south west corners. There is a 2% increase in flood extent for the 1% AEP event. A flow route from the west to the centre of the site is further established for this event and further flooding along the railway line. An increase of 10% occurs for the 0.1% AEP event with the largest increase occurring along the eastern site boundary.

It should be noted that this dataset does not account for tide locking which could exacerbate the surface water risk at the site given the proximity of the Thames to the north and tidal influence within the River Ebbsfleet to the east of the site

The RoFSW modelling takes account of building footprints so the flood risk may be affected by existing buildings on the site. It also only considers flood risk where the hazard rating is greater than 0.575.

The Areas Susceptible to Groundwater Flooding (AStGWF) dataset shows the site is located within a 1km grid square where less than 25% of the 1km grid square are considered to be susceptible to groundwater flooding.

Site name	Ebbsfleet Central

		The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist. It should be noted that soils present at the site are loamy and clayey soils with naturally high groundwater, therefore high groundwater levels are expected to be present at the site.
		The Environment Agency Risk of Flooding from Reservoirs dataset does not show the site to be at risk of reservoir flooding.

Site name	Ebbsfleet Central

		Tidal embankment	0.1% AEP	3
		Tidal concrete wall	0.1% AEP	2
			The River Ebbsfleet is culverted in a number of locations along the east site boundary which could present a residual risk in the event of a blockage.	
			The site is not at risk of flooding due to reservoir breach.	
			The Thames tidal defences pose a residual risk to the site in the event of a breach. Modelling was undertaken in 2018 to assess the risk of breach from these defences. Results of modelling show that the site is intersected by the 0.5% AEP breach extent in the north east corner of the site. This impacts 1% of the site. There is an increase in extent of 1% for the 0.1% AEP breach event. In the future, the site is predicted to increase in risk by 6% for the 0.5% AEP (2115 Upper End) breach event. Areas along the east boundary and the railway line are predicted to increase in risk. For the 0.1% AEP (2115 Upper End), an increase of 6% is predicted to occur. Risk remans confined to the eastern boundary and a section of the railway line north of Ebbsfleet International Station. The site is therefore predicted to be at an increased risk from breach due to climate change in the future.	
			The site does not benefit from any additional flood risk management infrastructure along the Ebbsfleet River.	
		The site is situated within the Coast from Dartford to Allhallows (064WAT1ThamesEst) Flood Alert area and the Gravesend and Northfleet (064FWT1Gravesend) Flood Warning areas.		
		Safe access and egress may be available during all surface water and fluvial flood events from the south west via Southfleet Road.		
		Thames		
			4%	4%	4%

Site name	Ebbsfleet Central

<table>
<tr><td rowspan="4"></td><td></td><td>There is a small increase in extent for all climate change allowances in comparison to the 1% AEP flood extent. For the Upper End (70% increase in peak river flows), the flood extent exceeds that of the 0.1% AEP flood extent. Therefore, climate change is predicted to impact the proposed site in the future. The potential change should be considered in the preparation of detailed proposals and assessed in an FRA. A sequential approach should be adopted to the layout and design at the site.
The site is affected by flood risk both under existing conditions and in the future. A commitment will be required to measures so that development is safe, and third parties are not adversely affected by proposals. This could potentially be achieved by provision of wider strategic measures, site specific measures, or a combination of these.</td></tr>
<tr><td rowspan="3"></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>4%</td><td>5%</td><td>7%</td></tr>
<tr><td></td><td>A small increase in flood extent during the 1% AEP surface water event is predicted for the plus 20% and 40% climate change events. However, the extents do not reach that of the 0.1% AEP surface water flood event. Therefore, the site will be at a slightly higher risk from surface water flooding in the future.
However, it should be noted that this dataset does not take account of the impact of tide locking from increased sea levels on drainage from the site which could exacerbate the surface water risk at the site in the future. The implications of the predicted changes should be addressed in an FRA and appropriate provisions incorporated in the design and layout.</td></tr>
</table>

Site name	Ebbsfleet Central

		The site's bedrock consists of White Chalk.
		The site is overlain with alluvium deposits (clay, silt and sand) to the north of the site.
		Loamy and clayey soils of coastal flats with naturally high groundwater
		The site is partially located within Groundwater Source Protection Zones 1, 2 and 3.
		There are historic landfill located within the site boundary.

Site name	Ebbsfleet Central

		Implementation of SuDS at the site could provide opportunities to deliver multiple benefits including volume control, water quality, amenity and biodiversity. This could provide wider sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. British Geological Society (BGS) data indicates that the underlying geology is the White Chalk subgroup and is likely to be freely draining. This should be confirmed through infiltration test, with the use of infiltration maximised as much as possible. The site is located within Groundwater Source Protection Zones 1, 2 and 3 (SPZ). Kent County Council and the Environment Agency have confirmed that in GSPZ 2 and 3, infiltration is potentially possible for surface run-off from roads, car parking and public or amenity provided the SUDS management train is used to treat the drainage. In GSPZ 1 only infiltration from clean roof drainage will potentially be permitted, with appropriate measures in place. Due to the soil type present at the site, groundwater levels may be less than 1m below ground level. Groundwater ingress could potentially impact the hydraulic capacity and structural integrity of detention and attenuation features, if measures to prevent this are not implemented in the design of the surface water drainage system. Additional site investigation work may be required to support the detailed design of the drainage system. This may include groundwater monitoring to demonstrate that a sufficient unsaturated zone has been provided above the highest occurring groundwater level. Filtration features may not be suitable given the depth to the water table may be <1m due to the soils at the site. If the site has contamination or groundwater issues; a liner will be required. This should be confirmed as part of ground investigation works. All forms of conveyance are likely to be suitable. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. Overland flows paths are present at the development site, where possible opportunities to incorporate these flow paths into the site layout should be considered. If the site has contamination or groundwater issues; a liner will be required. If it is proposed to discharge runoff to a watercourse or sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and discharge rate agreed with the asset owner. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints.

Site name	Ebbsfleet Central

		The majority of the site is located in a catchment with a high sensitivity to development. However, the south of the site is within a catchment with a low sensitivity and the north of the site in a catchment with a high sensitivity. The implications of increased volumes from proposed development should be addressed at an appropriate catchment level to demonstrate that additional volumes do not exacerbate flood risk at vulnerable locations remote from the site. This wider assessment should include consideration of other proposed development within the catchments(s).

	90%	**2%**	**5%**	**3%**

The Sequential Test must be satisfied based on fluvial and other sources of flood risk before the Exception test is applied.

The Exception test will be required in the following scenario:

- If Highly vulnerable development is proposed to be located in Flood Zone 2.
- If Most vulnerable or Essential Infrastructure development is proposed to be located in Flood Zone 3.
- If Essential infrastructure is proposed to be located in Flood Zone 3b.

Development will not be permitted for the following scenario:

- Highly vulnerable development within Flood Zone 3a.
- Highly vulnerable, More vulnerable and / or Less vulnerable development within Flood Zone 3b.

- At the planning application stage, a site-specific flood risk assessment will be required for this site as it is greater than 1 hectare in size, is located within Flood Zone 2 and 3 and may be subject to other sources of flooding where the development would introduce a more vulnerable use and contains land identified in the strategic flood risk assessment as being at increased flood risk in the future. It is also required where development:
  - Is on land which has been identified by the Environment Agency as having critical drainage problems; or
  - Other sources of flooding must be considered as part of any site-specific flood risk assessment, including surface water and groundwater.
  - Consideration should be given to the potential effects of climate change, particularly with respect to surface water. Proposals should consider the opportunity to include measures that provide for a reduction in predicted surface water flood risk at existing development.
  - Climate change modelling should be undertaken using the relevant allowances for the type of development and level of risk.
  - Where there is a reasonable likelihood of multiple sources of flood risk having significant impact, it is recommended that consideration is given to assessing the combined risks of these.
  - Consultation with the Local Authority, Lead Local Flood Authority and Environment Agency should be undertaken at an early stage.
  - Proposals will need to demonstrate that the site can adopt a sequential approach with more vulnerable uses located outside Flood Zone 3a and 2 where possible.
  - Consideration must be given to the flood risk management measures and commitments required to make development safe over the intended lifetime.
  - Cumulative effects should be considered (see above)

Guidance for site design and making development safe:

- New development must seek opportunities to reduce the overall level of flood risk at the site. For example, by:

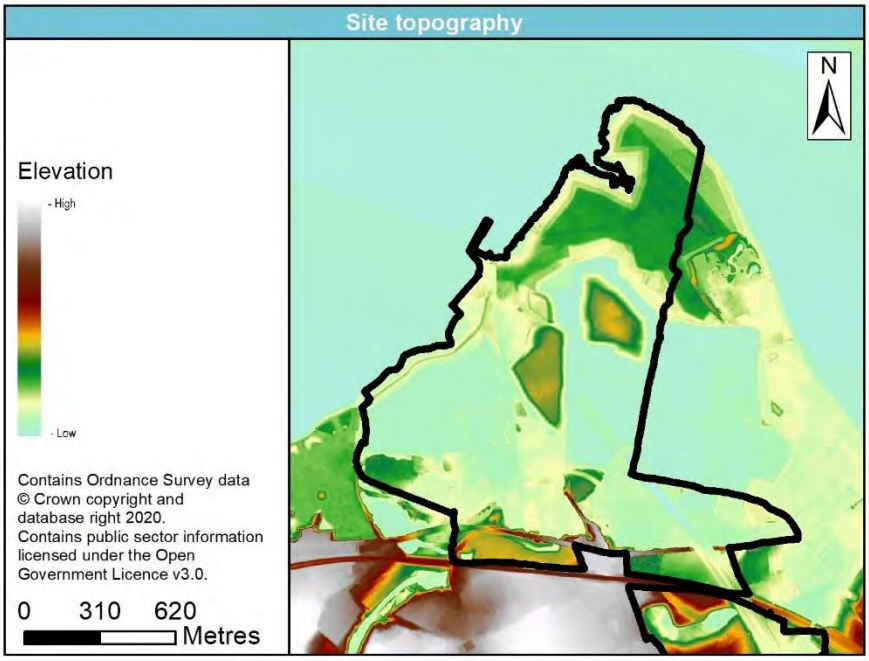
Site name	Ebbsfleet Central

	○ Reducing volume and rate of runoff ○ Relocating development to zones with lower flood risk ○ Creating space for flooding. • Safe access and egress should be demonstrated in the surface water 1% AEP plus climate change event. • All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post development runoff. • A greenfield site such as this should be able to implement an exemplar surface water drainage scheme to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc. • Example features include swales, attenuation features, green roofs, rainwater capture and reuse and permeable paving. • Assessment of runoff should include allowances for climate change effects. • Efforts should be made to limit runoff to greenfield rates and discharge rates from the site should not increase downstream flood risk. • According to the Environment Agency, development should seek to leave an undeveloped margin of 8m next to fluvial watercourses and 16m next to tidal watercourses. Any development within 8m either side of a Main River or within 16m from the foot of any sea defence may require the separate consent of the Environment Agency under local land drainage byelaws.

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

	Swanscombe Peninsula

		560370 E, 175566 N
		171.06
		Industrial and marshland
		Mixed use / residential / open space
		More vulnerable and less vulnerable.
		 • The ground slope across the site varies significantly. The site has varying ground levels with two areas of high ground located in the centre of the site, south west and north east corner. • There are a number of drainage ditches and waterbodies located on the site. • There are a few small existing buildings on the site but overall, the site is largely green field. • The presence of the buildings has also affected localised filtering of the LIDAR data.
		There are a number of unnamed watercourses and ditches located in the centre of the site which drain into the Thames which flows along the west and north site boundary. A small watercourse known as Swanscombe Marsh that is designated as Main River is also located within the site boundary.

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

Site name	Swanscombe Peninsula

The site is reported to have flooded twice with the northern half of the site being most affected. One incident was reported to have occurred in 1953 as a result of tidal overtopping of the defences. The second incident occurred in 1968 as a result of channel capacity exceedance and no raised defences.

Kent County Council may hold additional records which are not available at this time. These records detail historical flood incidents from all sources, whereas the Environment Agency dataset only records incidents of fluvial, tidal or coastal flooding. Please contact the Lead Local Flood Authority for further details.

1%	2%	4%

Available modelled data:

The site is covered by the Environment Agency North Kent Coast (Tidal) 2019 Flood Modeller-TUFLOW model. The extent of the Flood Zones predicted by the flood model are different to the extent of the actual flood risk, as there are flood risk management features that change the risk. The unnamed watercourses within the site are not covered by detailed modelling.

Flood characteristics:

The west corner of the site along the boundary is partially within Flood Zone 3b (5% AEP defended tidal flood event). This is further increased to 2% for the 0.5% AEP tidal event, risk remains contained along the west site boundary in proximity of the River Thames. A further small increase of 2% is predicted to occur for the 0.1% AEP tidal event with a small area of the north site boundary at risk for this event.

The unnamed watercourses located within the site are not covered by model data. Therefore, fluvial risk at the site would need to be confirmed as part of a site specific flood risk assessment.

1%	2%	7%

Description of surface water flow paths:

Surface water accumulation occurs in small areas of low topography within the southern half of the site for the 3.3% AEP event. There is a 1% increase in flood extent for the 1% AEP event with a large area of accumulation located in the centre of the site. Risk remains contained to the southern half of the site where ground elevations are lower. Risk is further increased by 5% for the 0.1% AEP event where there is a further expansion of extents in the south of the site along existing roads such as Manor Way and Lower Road.

It should be noted that this dataset does not account for tide locking which could exacerbate the surface water risk at the site given the proximity of the Thames to the north.

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

Site name	Swanscombe Peninsula

		RoFSW takes account of building footprints so the flood risk may be affected by existing buildings on the site. It also only considers flood risk where the hazard rating is greater than 0.575.		
		The Areas Susceptible to Groundwater Flooding (AStGWF) dataset shows the site is located within a 1km grid square where less than 25% of the 1km grid square are considered to be susceptible to groundwater flooding. The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist. It should be noted that soils present at the site are loamy and clayey soils with naturally high groundwater, therefore high groundwater levels are expected to be present at the site.		
		The Environment Agency Risk of Flooding from Reservoirs dataset does not show the site to be at risk of reservoir flooding.		
		Concrete Wall	0.1% AEP	3
		Earth Embankment	0.1% AEP	3
			There are two culverts located within the site which could present a residual risk in the event of a blockage.	
			The site is not at risk of flooding due to reservoir breach.	
			The Thames tidal defences pose a residual risk to the site in the event of a breach. Modelling was undertaken in 2018 to assess the risk of breach from these defences. Results of modelling show that the site is intersected by the 0.5% AEP breach extent. This impacts 42% of the site with land situated at low elevations in the south of the site being most at risk. There is an increase in extent of 8% for the 0.1% AEP breach event with areas of increase located to the south east of the site risk. In the future, the site is predicted increase in risk of 16% for the 0.5% AEP (2115 Upper End) breach event. For the 0.1% AEP (2115 Upper End) breach event, an increase of 11% is precited to occur. Areas located to south east of the site and to the north are predicted to be at an increased risk due to climate change in the future.	
		The site is situated within the Coast from Dartford to Allhallows (064WAT1ThamesEst) Flood Alert area and the Gravesend and Northfleet (064FWT1Gravesend) Flood Warning areas.		
		Safe access and egress may be available during all surface water and fluvial flood events from the south east via Galley Hill Road (A226).		

<table>
<tr><td rowspan="8">Climate Change</td><td rowspan="3"></td><td colspan="4"></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>South East</td><td>2%</td><td>4%</td><td>4%</td></tr>
<tr><td></td><td colspan="4">There is an increase in extent for all climate change allowances in comparison to the 0.5% AEP flood extent. For the year 2120 (Upper End), the flood extent reaches and slightly exceeds that of the current Flood Zone 2. Therefore, climate change is predicted to impact the proposed site in the future.</td></tr>
<tr><td rowspan="3"></td><td colspan="4"></td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">2%</td><td colspan="2">3%</td><td>4%</td></tr>
<tr><td></td><td colspan="4">A small increase in flood extent during the 1% AEP surface water event is predicted for the plus 20% and 40% climate change events. However, the extents do not reach that of the 0.1% AEP surface water flood event. Therefore, the site will be at a slightly higher risk from surface water flooding in the future.
However, it should be noted that this dataset does not take account of the impact of tide locking from increased sea levels on drainage from the site which could exacerbate the surface water risk at the site in the future.</td></tr>
<tr><td rowspan="5"></td><td></td><td colspan="4">The entire site’s bedrock geology consists of White Chalk.</td></tr>
<tr><td></td><td colspan="4">The site is overlain with alluvium deposits (clay, silt and sand)</td></tr>
<tr><td></td><td colspan="4">Loamy and clayey soils of coastal flats with naturally high groundwater</td></tr>
<tr><td></td><td colspan="4">The site is partially located within Groundwater Source Protection Zone 2 and 3.</td></tr>
<tr><td></td><td colspan="4">There are historic landfills located within the site boundary.</td></tr>
</table>

	Broad scale assessment of possible SuDS	Implementation of SuDS at the site could provide opportunities to deliver multiple benefits including volume control, water quality, amenity and biodiversity. This could provide wider sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. British Geological Society (BGS) data indicates that the underlying geology is the White Chalk subgroup and is likely to be freely draining. This should be confirmed through infiltration test, with the use of infiltration maximised as much as possible. The eastern part of the site is located within Groundwater Source Protection Zones 2 and 3 (SPZ). Kent County Council and the Environment Agency have confirmed that in GSPZ 2 and 3, infiltration is potentially possible for surface run-off from roads, car parking and public or amenity provided the SUDS management train is used to treat the drainage Due to the soil type present at the site, groundwater levels may be less than 1m below ground level. Groundwater ingress could potentially impact the hydraulic capacity and structural integrity of detention and attenuation features, if measures to prevent this are not implemented in the design of the surface water drainage system. Additional site investigation work may be required to support the detailed design of the drainage system. This may include groundwater monitoring to demonstrate that a sufficient unsaturated zone has been provided above the highest occurring groundwater level. Filtration features may not be suitable given the depth to the water table may be <1m due to the soils at the site. If the site has contamination or groundwater issues; a liner will be required. This should be confirmed as part of ground investigation works. All forms of conveyance are likely to be suitable. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. Overland flows paths are present at the development site, where possible opportunities to incorporate these flow paths into the site layout should be considered. If the site has contamination or groundwater issues; a liner will be required. If it is proposed to discharge runoff to a watercourse or sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and discharge rate agreed with the asset owner. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints.
		The site is almost entirely within a catchment that has a medium sensitivity to development, though the far eastern corner is in a catchment with a high sensitivity. It is unlikely that the site is in a location where cumulative effects will be influential.

12%	**30%**	**57%**	**1%**	

Local Plan policy	The Sequential Test must be satisfied based on fluvial and other sources of flood risk before the Exception test is applied. The Exception test will be required in the following scenario: • If Highly vulnerable development is proposed to be located in Flood Zone 2. • If Most vulnerable or Essential Infrastructure development is proposed to be located in Flood Zone 3. • If Essential infrastructure is proposed to be located in Flood Zone 3b. Development will not be permitted for the following scenario: • Highly vulnerable development within Flood Zone 3a. • Highly vulnerable, More vulnerable and / or Less vulnerable development within Flood Zone 3b.
	Flood risk assessment • At the planning application stage, a site-specific flood risk assessment will be required for this site as it is greater than 1 hectare in size, is located within Flood Zone 2 and 3 and may be subject to other sources of flooding where the development would introduce a more vulnerable use and contains land identified in the strategic flood risk assessment as being at increased flood risk in the future. It is also required where development: ○ Is on land which has been identified by the Environment Agency as having critical drainage problems; or ○ Other sources of flooding must be considered as part of any site-specific flood risk assessment, including surface water and groundwater. ○ Consideration should be given to the potential effects of climate change, particularly with respect to surface water. Proposals should consider the opportunity to include measures that provide for a reduction in predicted surface water flood risk at existing development. ○ Climate change modelling should be undertaken using the relevant allowances for the type of development and level of risk. ○ Where there is a reasonable likelihood of multiple sources of flood risk having significant impact, it is recommended that consideration is given to assessing the combined risks of these. ○ Consultation with the Local Authority, Lead Local Flood Authority and Environment Agency should be undertaken at an early stage. ○ Proposals will need to demonstrate that the site can adopt a sequential approach with more vulnerable uses located within lower risk parts of the site where possible. ○ Consideration must be given to the flood risk management measures and commitments required to make development safe over the intended lifetime. It should be noted that at the time of preparing this Level 2 SFRA, an FRA was being prepared for the site in association with the proposals for a London Resort. **Guidance for site design and making development safe:** • New development must seek opportunities to reduce the overall level of flood risk at the site. For example, by: ○ Reducing volume and rate of runoff ○ Relocating development to zones with lower flood risk ○ Creating space for flooding. • Safe access and egress should be demonstrated in the surface water 1% AEP plus climate change event. • All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post development runoff. • A greenfield site such as this should be able to implement an exemplar surface water drainage scheme to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc. • Example features include swales, attenuation features, green roofs, rainwater capture and reuse and permeable paving.

	• Assessment of runoff should include allowances for climate change effects. • Efforts should be made to limit runoff to greenfield rates and discharge rates from the site should not increase downstream flood risk. • The site has potential to reduce flood risk to the site and/or wider community by incorporating improved flood defences into the landscaping of the site. • According to the Environment Agency, development should seek to leave an undeveloped margin of 8m next to fluvial watercourses and 16m next to tidal watercourses. Any development within 8m either side of a Main River or within 16m from the foot of any sea defence may require the separate consent of the Environment Agency under local land drainage byelaws.

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

	Former Littlebrook Power Station

		555985 E, 176430 N
		45.58
		Industrial
		Employment – Approximately two-thirds of the site has already been granted planning permission for class B8 (storage and distribution) uses and ancillary class B1 uses as part of phased development at the site.
		Less Vulnerable
		 • The topography of the site generally slopes out from the high ground in the centre of the site in all directions. • The site sits upon land where ground levels are raised above the surround low lying marshes. Within the site boundary there is an area of low-lying ground in the southwest corner. • The LIDAR appears to represent former buildings at the site, many of which have since been demolished. • The ground slope across the site generally has a gradient of less than 5%,
		The River Thames (Main River) is located along the northern boundary of the site. Along the western boundary of the site there are several small drains, a section of which is classified as Main River. Additionally, a drain is located 20m east of the eastern boundary, with another drain partially located within the site boundary.

Site name	Former Littlebrook Power Station

		The drains flow towards an unnamed drain classified as Main River 135m east of the site.
		The Environment Agency's recorded flood outlines show the whole site was impacted by tidal flooding during the 1953 storm surge. Flooding is also recorded in the west of the site associated with the capacity of a Main River being exceeded in September 1968. Kent County Council may hold additional records which are not available at this time. These records detail historical flood incidents from all sources, whereas the Environment Agency dataset only records incidents of fluvial, tidal or coastal flooding. The Lead Local Flood Authority should be contacted to obtain further details.

0%	2%	2%

Available modelled data:
The site is covered by the Environment Agency North Kent Coast (Tidal) 2019 Flood Modeller-TUFLOW model. The extent of the Flood Zones predicted by the flood model are different to the extent of the actual flood risk, as there are flood risk management features that change the risk. The unnamed ditches located to the west and east of the site are not covered by detailed or broad scale modelling.

Flood characteristics:
The site is largely located within Flood Zone 3, with the entire site located in Flood Zone 2. However, when flood risk management features are accounted for, the site is at a small risk of tidal flooding during the 0.5% AEP event and the 0.1% AEP event with 2% of the site being interested by both flood extents along the north site boundary.

There may be fluvial flood risk from the unnamed ditches along the western and eastern boundaries of the site, though this has not been assessed as part of the Level 2 Assessment as modelling of the watercourses has not been prepared. Fluvial risk for the site will therefore need to be confirmed as part of a site-specific flood risk assessment. Fluvial risk from the River Thames to the north is considered to be negligible to the presence of flood risk management features.

0%	1%	7%

Site name	Former Littlebrook Power Station

		Description of surface water flow paths: The RoFSW mapping predicts surface water flooding at the site to be largely limited to the existing roads across the site in the 3.33% AEP event. There is also an area of surface water ponding predicted on the southwest border of the site, which is predicted to increase in size during the large events. In the 1% AEP events surface water flood risk is predicted to increase slightly by 1% and increase by 7% for the 0.1% AEP event, risk is largely contained to isolated areas of ponding within topographic depressions. It should be noted that this dataset does not account for tide locking which could exacerbate the surface water risk at the site given the proximity of the tidally influenced River Thames to the north. RoFSW takes account of building footprints so the flood risk may be affected by existing buildings on the site. It also only considers flood risk where the hazard rating is greater than 0.575.
		The Areas Susceptible to Groundwater Flooding (AStGWF) dataset shows the site is located within 1km grid squares where no risk is indicated, though the southeast corner of the site is located within a 1km grid square where <25% of the area is predicted to be at risk of groundwater flooding. The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist. Ground investigations at the site should be used to confirm groundwater levels to support the design of SUDS features.
		The Environment Agency Risk of Flooding from Reservoirs dataset does not show the site to be at risk of reservoir flooding.

Site name	Former Littlebrook Power Station

		Concrete wall	1000	2
		Earth embankment	1000	3
			There drainage ditches on the western boundary of the site are culverted through the Thames Frontage defences.	
			The site is not at risk of flooding due to reservoir breach.	
			The Thames tidal defences pose a residual risk to the site in the event of a breach. Modelling was undertaken in 2018 to assess the risk of breach from these defences. Results of modelling show that the site is intersected by the 0.5% AEP breach extent, with 68% of the site impacted in the west and east. There is an increase of 15% for the 0.1% AEP breach with the centre of the site also predicted to be at risk. In the future, the site is predicted increase in risk of 24% for the 0.5% AEP (2115 Upper End) breach event. For the 0.1% AEP (2115 Upper End) breach event, an increase of 10% is precited to occur. Areas located in the centre of the site are predicted to be at a greater risk of flooding in the future as a result of climate change.	
		The site is situated within the Coast from Dartford to Allhallows (064WAT1ThamesEst) Flood Alert area and the Dartford, Crayford and Greenhithe (064FWT1Dartford) Flood Warning areas. The area along the western boundary of the site is also within the (064WAF7Darent) Flood Alert Area and (064FWF7Dartford) Flood Warning Area associated with the River Darent.		
		Safe access and egress may be available during all surface water and tidal flood events from the south via Rennie Drive.		
		Thames	2%	2%	2%

Site name	Former Littlebrook Power Station

<table>
<tr><td rowspan="5"></td><td></td><td colspan="3">Due to the presence of flood risk management features, the site is not predicted to be at risk in the future from tidal flooding, with the slight increases in flood extent predicted to occur on the Thames side of the defences within the site boundary.

The impact of climate change on fluvial flood risk from the unnamed ditches along the western and eastern boundaries of the site has not been assessed as part of the Level 2 Assessment as modelling of the watercourses has not been prepared.</td></tr>
<tr><td rowspan="3"></td><td colspan="3"></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>1%</td><td>2%</td><td>3%</td></tr>
<tr><td></td><td colspan="3">Climate change is predicted to have a negligible impact on surface water flood risk, with only very slight increases in flood extents predicted from the 1% AEP event when rainfall is uplifted by 20% and 40%.
However, it should be noted that this dataset does not take account of the impact of tide locking from increased sea levels on drainage from the site which could exacerbate the surface water risk at the site in the future.</td></tr>
</table>

Site name	Former Littlebrook Power Station

		The entire site's bedrock geology consists of White Chalk.
		The southwest of the site is overlain with alluvium deposits (clay, silt and sand), with no deposits recorded in the rest of the site.
		Loamy and clayey soils of coastal flats with naturally high groundwater are recorded across the entire site.
		The site not located within a Groundwater Source Protection Zone.
		A historic landfill site associated with the Former Littlebrook Power Station covers the entire site.

Site name	Former Littlebrook Power Station

		Implementation of SuDS at the site could provide opportunities to deliver multiple benefits including volume control, water quality, amenity and biodiversity. This could provide wider sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. British Geological Society (BGS) data indicates that the underlying geology is the White Chalk subgroup, though the soils at the site are loamy and clayey with high groundwater levels. Groundwater levels and the permeability of soils at the site should be assessed via an infiltration test, with the use of infiltration maximised as much as possible. Off-site discharge in accordance with the SuDS hierarchy may be required to discharge surface water runoff from the site. Groundwater ingress could potentially impact the hydraulic capacity and structural integrity of detention and attenuation features, if measures to prevent this are not implemented in the design of the surface water drainage system. As the site is recorded as a historic landfill site, opportunities to incorporate filtration techniques such as filter strips, filter drains and bioretention areas should be considered. The use of multistage SuDS of runoff will improve water quality and reduce the potential impact on receiving water bodies. Given the high-density nature of the site, use of urban SuDS is recommended. Urban sites should not preclude the use of SuDS. It may be possible to reduce site runoff by maximising the permeable surfaces on site using a combination of permeable surfacing and soft landscaping techniques. Mapping suggests that the site slopes make it possible to consider most forms of dentition. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. The potential to utilise conveyance features such as swales to intercept and convey surface water runoff should be considered. Conveyance features should be located on common land or public open space to facilitate ease of access. Where slopes are >5%, features should follow contours or utilise check dams to slow flows. If it is proposed to discharge runoff to the River Thames, local drainage network or sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and discharge rate agreed with the asset owner. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA. Surface water outfalls that discharge into the Thames may be affected by tide locking due to water levels in the Thames. The impacts of tide locking/flood flows will need to be considered in terms of the attenuation storage requirements of the site. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints.

Site name	Former Littlebrook Power Station

		The northwest of the site is located within a catchment with a high sensitivity to cumulative impacts of development. The east of the site is within a catchment with a medium sensitivity and the south within a catchment with a low sensitivity. The location of the development makes it appropriate for consideration to be given to the additional potential requirements resulting from increased run-off volumes generated by other new development tin the catchment.

0%	**19%**	**81%**	**0%**

The Sequential Test must be satisfied based on fluvial and other sources of flood risk before the Exception test is applied.

The Exception test will be required in the following scenario:

- Highly vulnerable and in flood zone 2
- Essential infrastructure in flood zone 3a or 3b
- More vulnerable in flood zone 3a

Development will not be permitted for the following scenario:

- Highly vulnerable development within FZ3a.
- Highly vulnerable, More vulnerable and / or Less vulnerable development within FZ3b.

Flood risk assessment

- At the planning application stage, a site-specific flood risk assessment will be required for this site as it is located within Flood Zone 2 and 3 and may be subject to other sources of flooding where the development would introduce a more vulnerable use and contains land identified in the strategic flood risk assessment as being at increased flood risk in the future. It is also required where development:
  - Is on land which has been identified by the Environment Agency as having critical drainage problems; or
  - Other sources of flooding must be considered as part of any site-specific flood risk assessment, including surface water and groundwater.
  - Consideration should be given to the risk of fluvial flooding associated with the drainage ditches located to the west and east of the site.
  - Consideration should be given to the potential effects of climate change, particularly with respect to surface water. Proposals should consider the opportunity to include measures that provide for a reduction in predicted surface water flood risk at existing development.
  - Climate change modelling should be undertaken using the relevant allowances for the type of development and level of risk.
  - Where there is a reasonable likelihood of multiple sources of flood risk having significant impact, it is recommended that consideration is given to assessing the combined risks of these.
  - Consultation with the Local Authority, Lead Local Flood Authority and Environment Agency should be undertaken at an early stage.
  - Consideration must be given to the flood risk management measures and commitments required to make development safe over the intended lifetime.
  - Include consideration of potential requirements associated with cumulative development within the upstream catchment.

Guidance for site design and making development safe:

- New development must seek opportunities to reduce the overall level of flood risk at the site. For example, by:

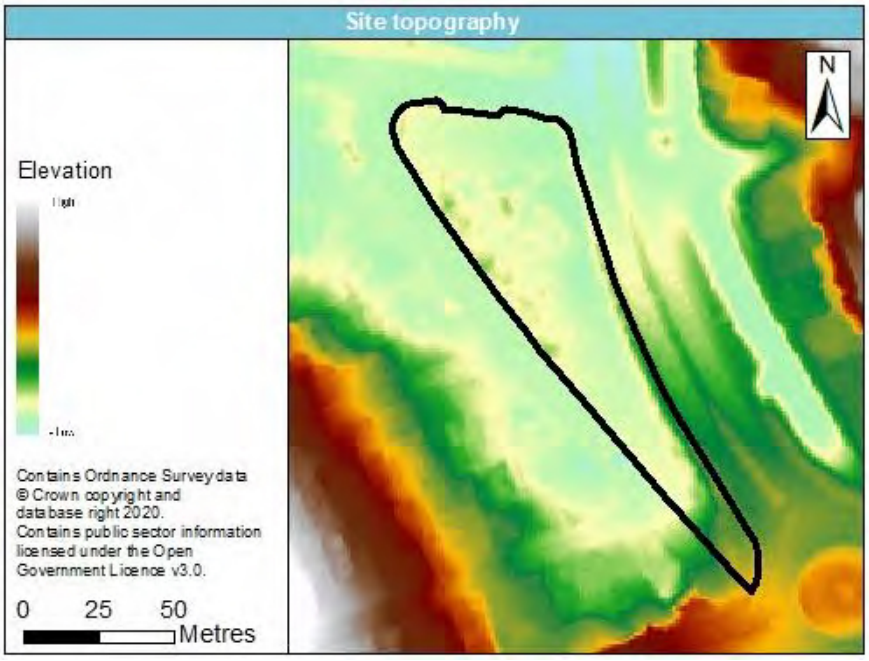
Site name	Former Littlebrook Power Station

	○ Reducing volume and rate of runoff ○ Relocating development to zones with lower flood risk ○ Creating space for flooding. • Safe access and egress should be demonstrated in the fluvial and tidal plus climate change events. Consideration should also be given to providing safe access and egress during surface water events. • According to the Environment Agency, development should seek to leave an undeveloped margin of 16m next to tidal watercourses. Any development within 8m either side of a Main River or within 16m from the foot of any sea defence may require the separate consent of the Environment Agency under local land drainage byelaws. • All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post development runoff. • Ground investigations at the site should be undertaken to confirm groundwater levels and the permeability of soils to support the design of SUDS features. • SuDS should be designed to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc. • Example features include swales, attenuation features, green roofs, rainwater capture and reuse and permeable paving. • Assessment of runoff should include allowances for climate change effects. • Efforts should be made to limit runoff to greenfield rates and discharge rates from the site should not increase downstream flood risk. • SuDS design must follow Kent County Council policy, meet the Defra National Non-Statutory Technical Standards, and follow current best practice (CIRIA C752 Manual 2015). • The site has potential to reduce flood risk to the site and/or wider community by incorporating improved flood defences into the landscaping of the site. • According to the Environment Agency, development should seek to leave an undeveloped margin of 8m next to fluvial watercourses and 16m next to tidal watercourses. Any development within 8m either side of a Main River or within 16m from the foot of any sea defence may require the separate consent of the Environment Agency under local land drainage byelaws.

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

	South of Steele Avenue

		558372 E, 174738 N
		0.56 ha
		Car park and open land
		Residential and/or health
		More vulnerable
		 • The is generally flat, although there is a slight downhill slope from south east to north west. • The ground slope across the site generally has a gradient of less than 5%.
		The River Thames (Main River) is located 400m to the north of the site. 780m North West of the site, there is an unnamed watercourse classified as Main River which feeds into the River Thames.

Dartford Borough Council

Level 2 SFRA Detailed Site Summary Tables – FINAL DOCUMENT

Site name	South of Steele Avenue

There are no historical incidents reported to have occurred at the site within the Environment Agency Recorded Flood Outlines dataset.

Kent County Council may hold additional records which are not available at this time. These records detail historical flood incidents from all sources, whereas the Environment Agency dataset only records incidents of fluvial, tidal or coastal flooding. Please contact the Lead Local Flood Authority for further details.

0%	0%	0%

Available modelled data:
The site is covered by the Environment Agency North Kent Coast (Tidal) 2019 Flood Modeller-TUFLOW model. The extent of the Flood Zones predicted by the flood model are different to the extent of the actual flood risk, as there are flood risk management features that change the risk. The unnamed watercourses located to the north west and north east of the site are not covered by detailed modelling.

Flood characteristics:
The site is partially located within Flood Zone 3a in the north east corner of the site and Flood Zone 2 for the north and west of the site. However, when flood risk management features are accounted for, the site is at a negligible risk of fluvial/tidal flooding during the 0.5% AEP event. This is due to the presence of tidal defences located along the River Thames.

Due to the presence of the defences along the Thames, fluvial risk to the site is also considered to be negligible.

1%	10%	28%

Description of surface water flow paths:
Surface water accumulation occurs in a small area along King Edward Road during the 3.3% AEP event and intersects the west site boundary. There is a 9% increase in flood extent for the 1% AEP with accumulation also occurring in the centre of the site. This is further increased by 18% for the 0.1% AEP event where there is a flow path originating from King Edward Road flowing to the north east corner of the site and exiting onto the A206.

It should be noted that this dataset does not account for tide locking which could exacerbate the surface water risk at the site given the proximity of the Thames to the north.
RoFSW takes account of building footprints so the flood risk may be affected by existing buildings on the site. It also only considers flood risk where the hazard rating is greater than 0.575.

The Areas Susceptible to Groundwater Flooding (AStGWF) dataset shows the site is not located within a 1km grid square. This means the risk of flooding from groundwater is predicted to be negligible for the site.

Site name	South of Steele Avenue

		The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.		
		The Environment Agency Risk of Flooding from Reservoirs dataset does not show the site to be at risk of reservoir flooding.		
		Concrete Wall	0.1% AEP	3
		Earth Embankment	0.1% AEP	3
			There are no known culverts or structures in the vicinity of the site.	
			The site is not at risk of flooding due to reservoir breach.	
			The Thames tidal defences pose a residual risk to the site in the event of a breach. Modelling was undertaken in 2018 to assess the risk of breach from these defences. Results of modelling show that the site is partially intersected (<1%) by the present day 0.1% AEP breach extent in the north east corner of the site. In the future, the site is predicted to cause flooding of 58% in the north of the site for the 0.5% (2115 Upper End) breach extent. There is an increase of 19% for the 0.1% (2115 Upper End) breach extent. The site is therefore predicted to be at an increased risk from breach in the future.	
		The site is situated within the Coast from Dartford to Allhallows (064WAT1ThamesEst) Flood Alert area and the Dartford, Crayford and Greenhithe (064FWT1Dartford) Flood Warning areas.		
		Safe access and egress may be available during all surface water and fluvial flood events from the south via London Road.		
		South East	0%	0%	0%
		Due to the presence of flood risk management features, the site is not predicted to be at risk in the future from tidal or fluvial flooding.		
		10%	14%	17%

Site name	South of Steele Avenue

		A small increase in flood extent during the 1% AEP surface water event is predicted for the plus 20% and 40% climate change events. However, the extents do not reach that of the 0.1% AEP surface water flood event. These increases are located across the centre of the site and adjacent to King Edward Road. Therefore, the site will be at a slightly higher risk from surface water flooding in the future. However, it should be noted that this dataset does not take account of the impact of tide locking from increased sea levels on drainage from the site which could exacerbate the surface water risk at the site in the future.

Site name	South of Steele Avenue

		The entire site's bedrock geology consists of White Chalk.
		The site is overlain with alluvium deposits (clay, silt and sand)
		The site has freely draining slightly acid but baserich soils.
		The site is located with Groundwater Source Protection Zone 2.
		There is a historic landfill site located 160m to the west of the site and 210m to the east of the site.

Site name	South of Steele Avenue

		Implementation of SuDS at the site could provide opportunities to deliver multiple benefits including volume control, water quality, amenity and biodiversity. This could provide wider sustainability benefits to the site and surrounding area. Proposals to use SuDS techniques should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. Development at this site should not increase flood risk either on or off site. The design of the surface water management proposals should take into account the impacts of future climate change over the projected lifetime of the development. British Geological Society (BGS) data indicates that the underlying geology is the White Chalk subgroup and is likely to be freely draining. This should be confirmed through infiltration test, with the use of infiltration maximised as much as possible. The entire site is located within Groundwater Source Protection Zone 2 (SPZ). Kent County Council and the Environment Agency have confirmed that in GSPZ 2, infiltration is potentially possible for surface run-off from roads, car parking and public or amenity provided the SUDS management train is used to treat the drainage Given the high-density nature of the site, use of urban SuDS is recommended. Urban sites should not preclude the use of SuDS. It may be possible to reduce site runoff by maximising the permeable surfaces on site using a combination of permeable surfacing and soft landscaping techniques. Mapping suggests that the site slopes make it possible to consider most forms of dentition. Opportunities to incorporate source control techniques such as green roofs, permeable surfaces and rainwater harvesting should be considered in the design of the site. Overland flows paths are present at the development site, where possible opportunities to incorporate these flow paths into the site layout should be considered. If it is proposed to discharge runoff to a watercourse or sewer system, the condition and capacity of the receiving watercourse or asset should be confirmed through surveys and discharge rate agreed with the asset owner. Opportunities to further reduce discharge rates should be considered and agreed with the LLFA. Proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible opportunities and constraints.
		The site is located within a catchment with a medium sensitivity to development. The scale of potential development and location in the catchment make it unlikely that there is a requirement to consider cumulative effects at a catchment scale.

14%	**67%**	**19%**	**0%**

The Sequential Test must be satisfied based on fluvial and other sources of flood risk before the Exception test is applied.

The Exception test will be required in the following scenario:

- If Highly vulnerable development is proposed to be located in Flood Zone 2.

Site name	South of Steele Avenue

- If Most vulnerable or Essential Infrastructure development is proposed to be located in Flood Zone 3.
- If Essential infrastructure is proposed to be located in Flood Zone 3b.

Development will not be permitted for the following scenario:

- Highly vulnerable development within Flood Zone 3a.
- Highly vulnerable, More vulnerable and / or Less vulnerable development within Flood Zone 3b.

Flood risk assessment

- At the planning application stage, a site-specific flood risk assessment will be required for this site as it is located within Flood Zone 2 and 3 and may be subject to other sources of flooding where the development would introduce a more vulnerable use and contains land identified in the strategic flood risk assessment as being at increased flood risk in the future. It is also required where development:
  - Is on land which has been identified by the Environment Agency as having critical drainage problems; or
  - Other sources of flooding must be considered as part of any site-specific flood risk assessment, including surface water and groundwater.
  - Consideration should be given to the potential effects of climate change, particularly with respect to surface water. Proposals should consider the opportunity to include measures that provide for a reduction in predicted surface water flood risk at existing development.
  - Climate change modelling should be undertaken using the relevant allowances for the type of development and level of risk.
  - Where there is a reasonable likelihood of multiple sources of flood risk having significant impact, it is recommended that consideration is given to assessing the combined risks of these.
  - Consultation with the Local Authority, Lead Local Flood Authority and Environment Agency should be undertaken at an early stage.
  - Proposals will need to demonstrate that the site can adopt a sequential approach with more vulnerable uses located within lower risk parts of the site where possible.
  - Consideration must be given to the flood risk management measures and commitments required to make development safe over the intended lifetime.

Guidance for site design and making development safe:

- New development must seek opportunities to reduce the overall level of flood risk at the site. For example, by:
  - Reducing volume and rate of runoff
  - Relocating development to zones with lower flood risk
  - Creating space for flooding.
- Safe access and egress should be demonstrated in the surface water 1% AEP plus climate change event.
- All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post development runoff.
- A greenfield site such as this should be able to implement an exemplar surface water drainage scheme to deliver multiple benefits including water quality, biodiversity, amenity, green infrastructure etc.
- Example features include swales, attenuation features, green roofs, rainwater capture and reuse and permeable paving.
- Assessment of runoff should include allowances for climate change effects.
- Efforts should be made to limit runoff to greenfield rates and discharge rates from the site should not increase downstream flood risk.
- SuDS design must follow Kent County Council policy, meet the Defra National Non-Statutory Technical Standards, and follow current best practice (CIRIA C752 Manual 2015).

SFRA: APPENDIX N LEVEL 2 SFRA SITE SUMMARY SHEET MAPPING

Site name	
Site area (ha)	4.44

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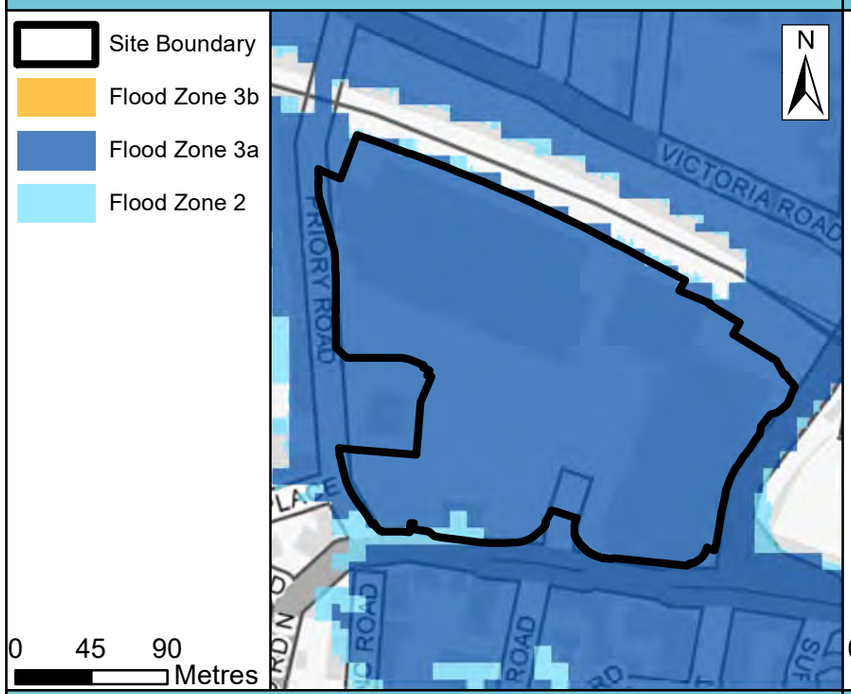

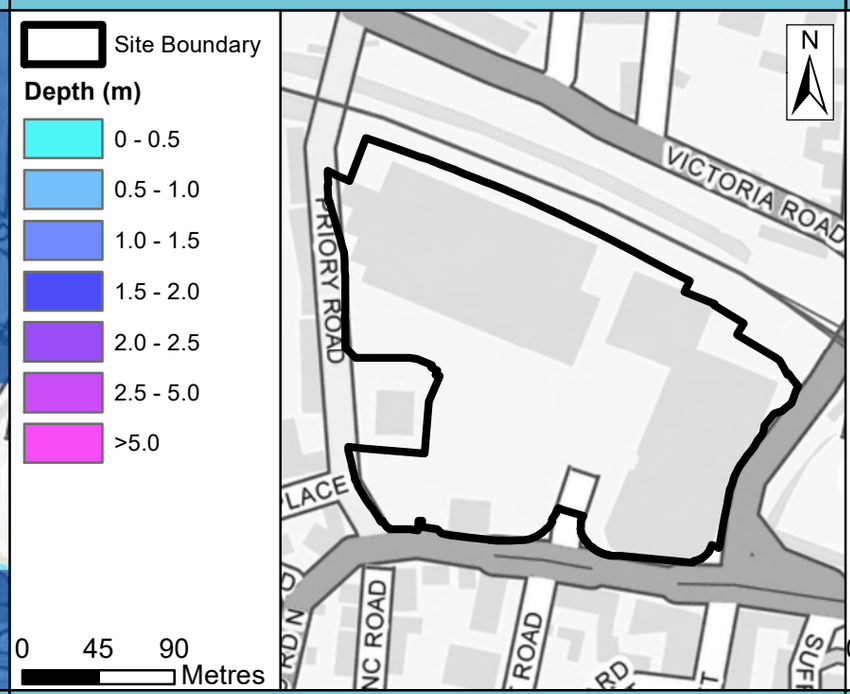

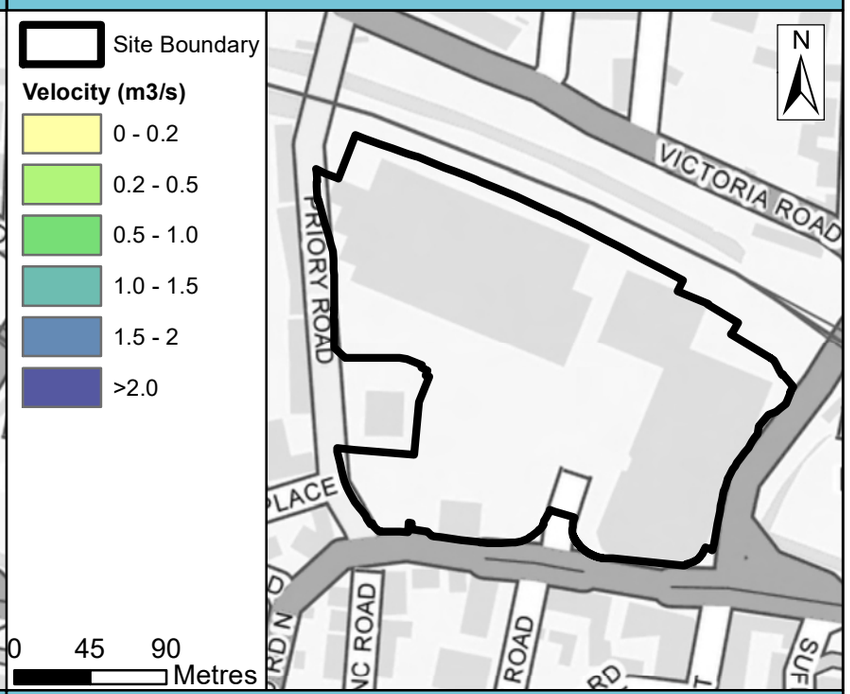

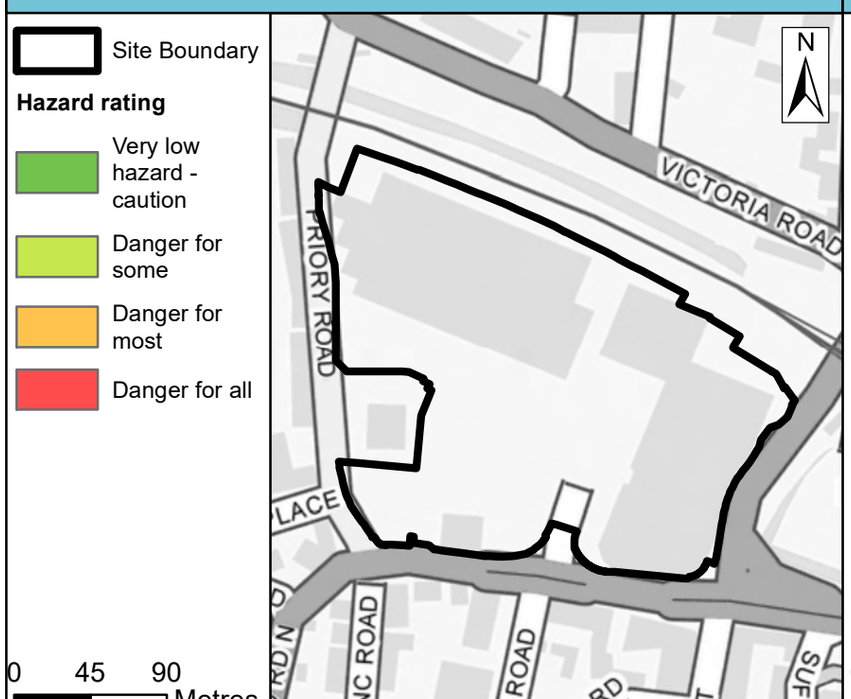

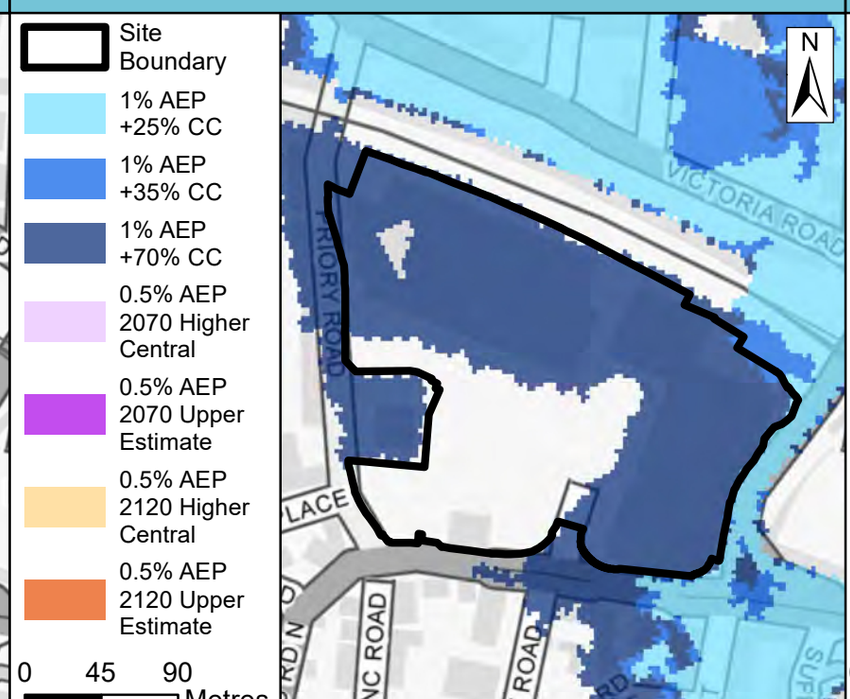

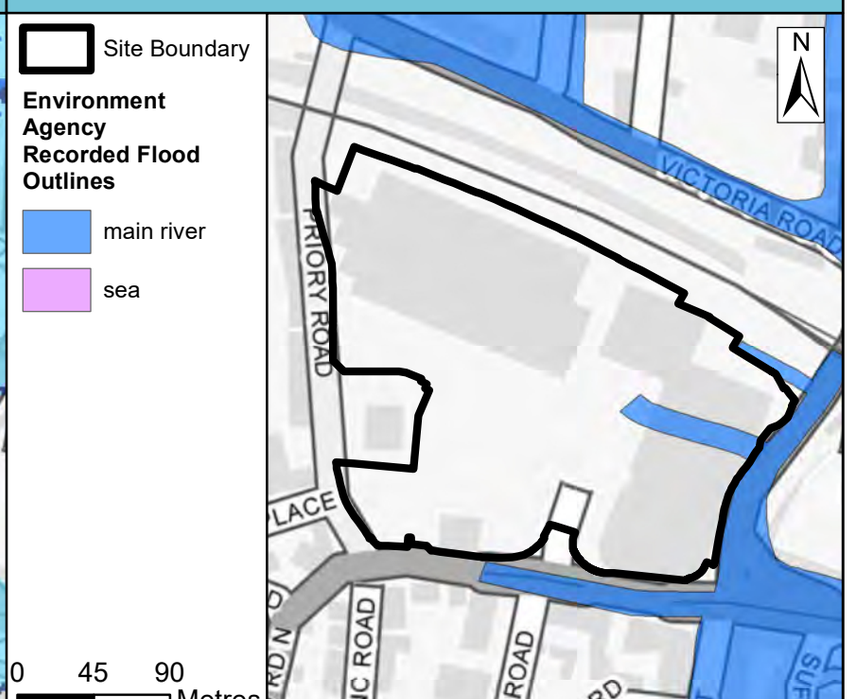

Site name	
Site area (ha)	4.44

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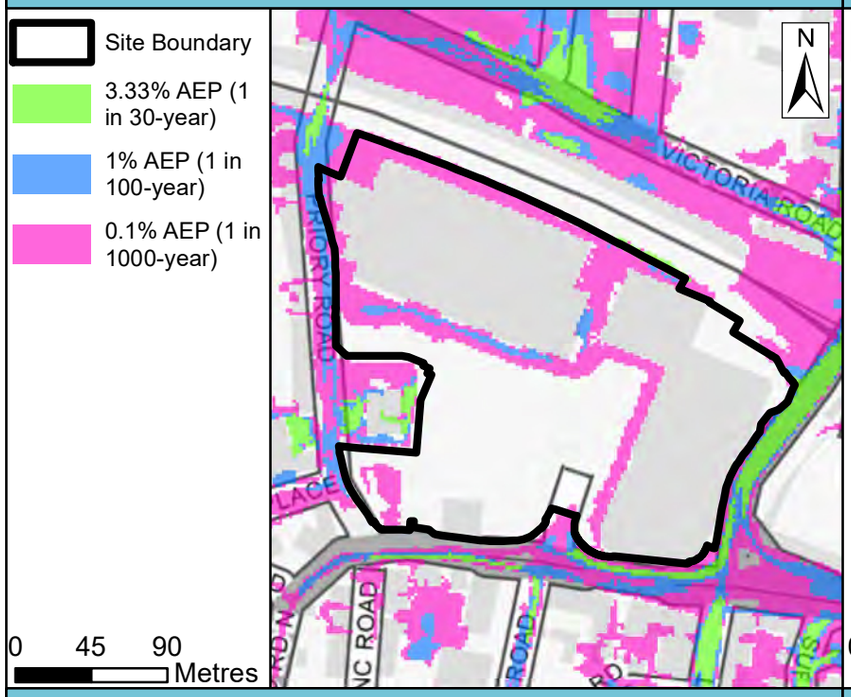

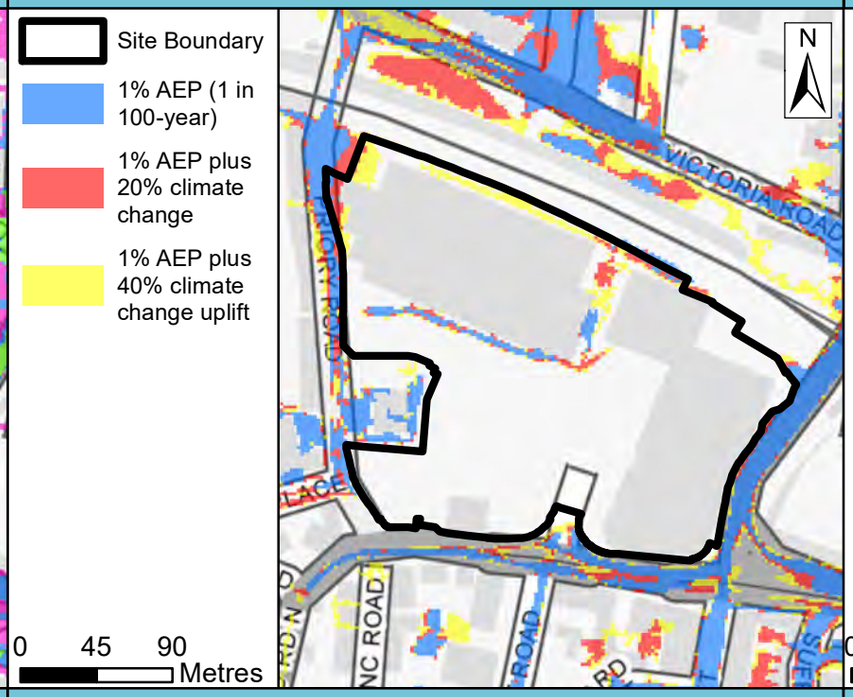

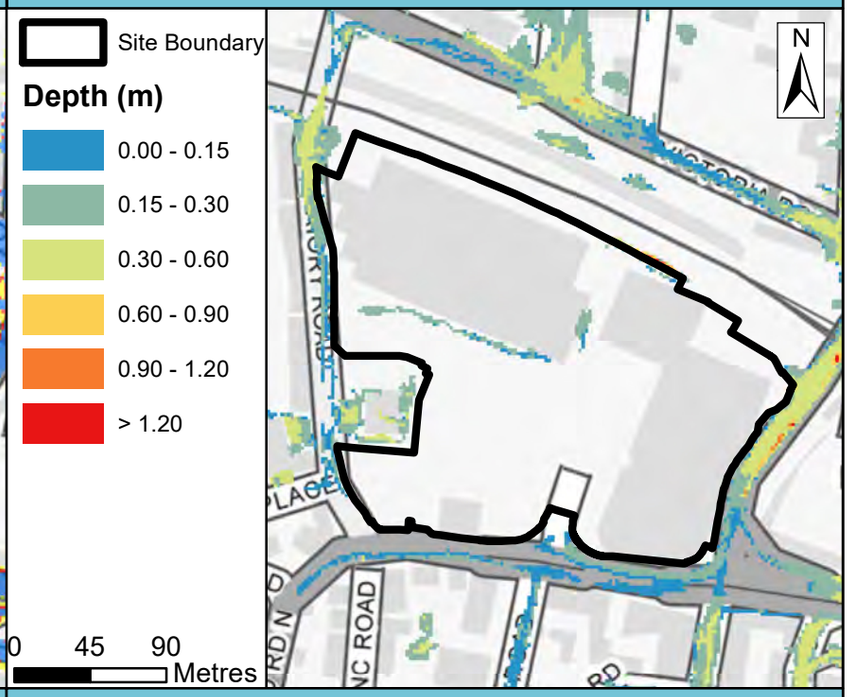

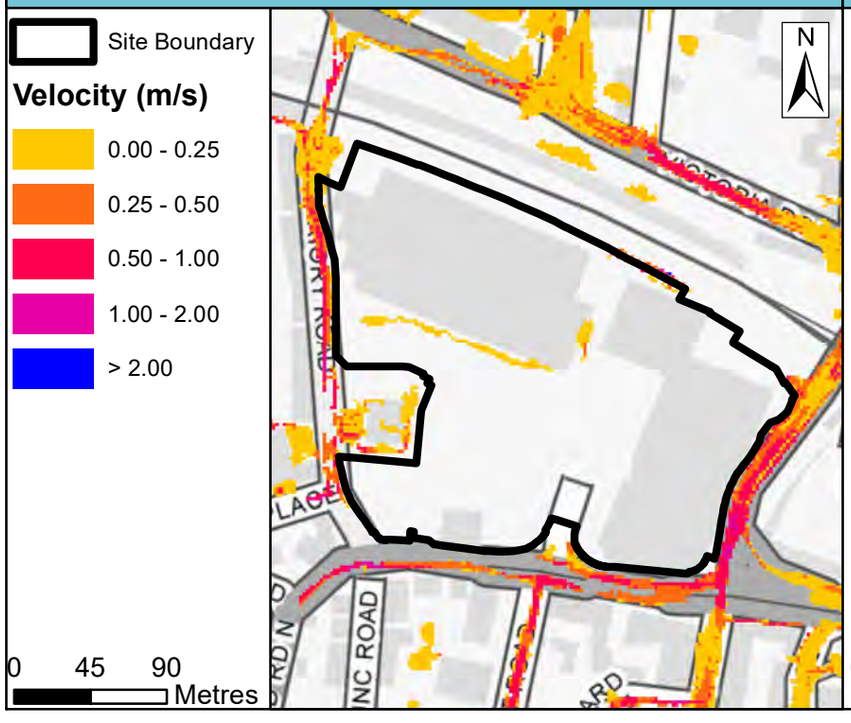

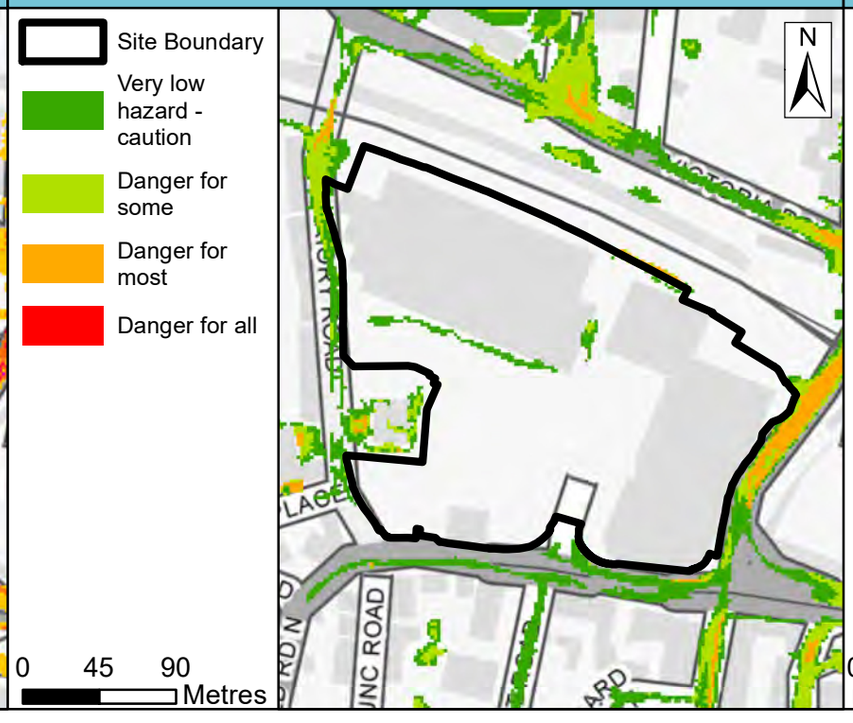

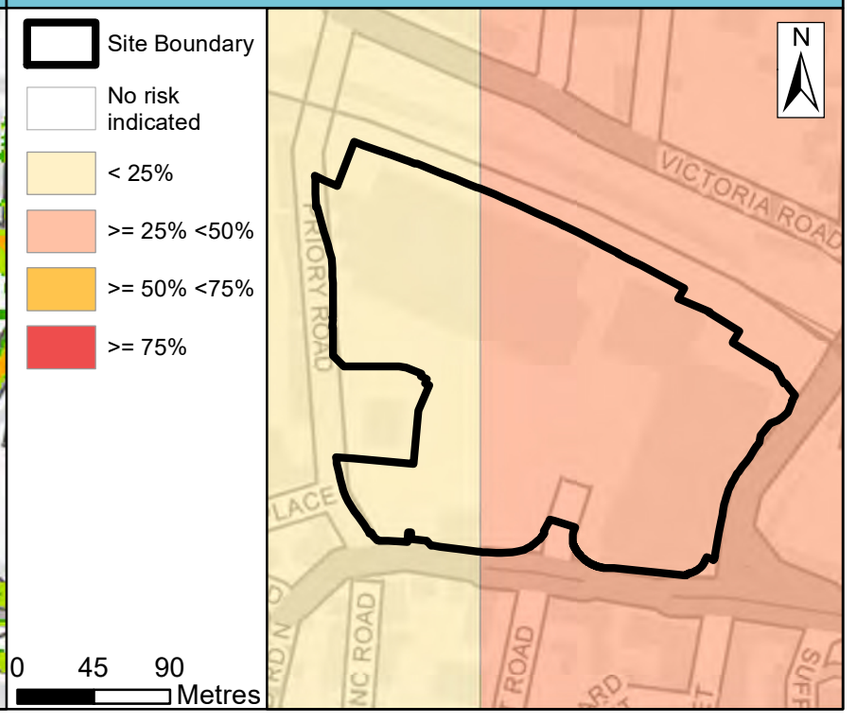

Site name	
Site area (ha)	4.44

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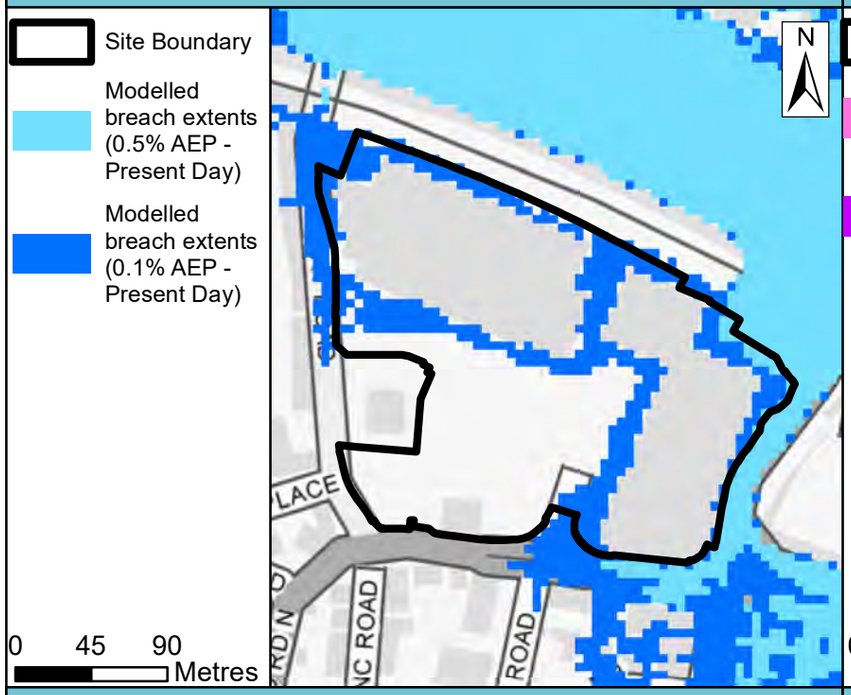

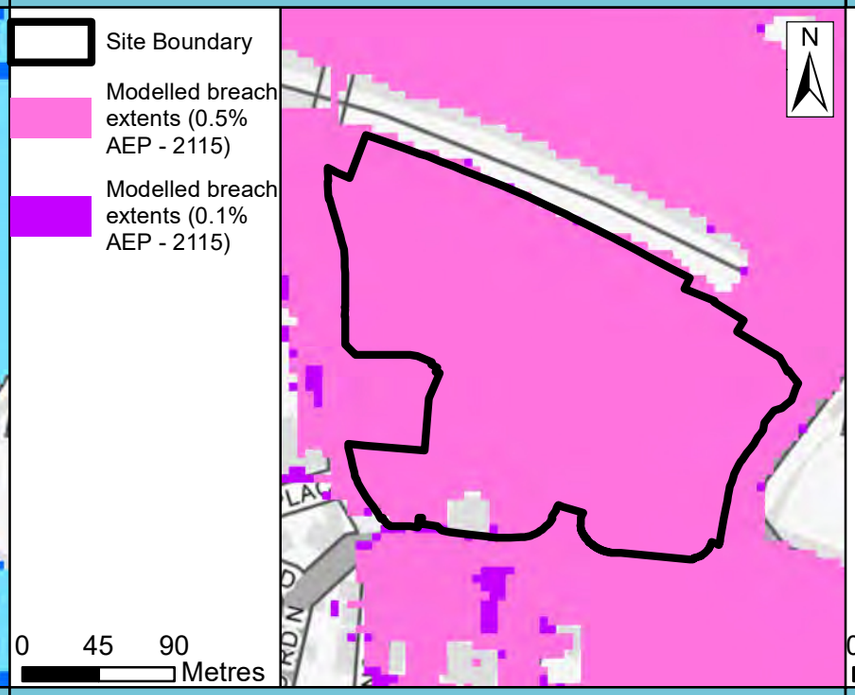

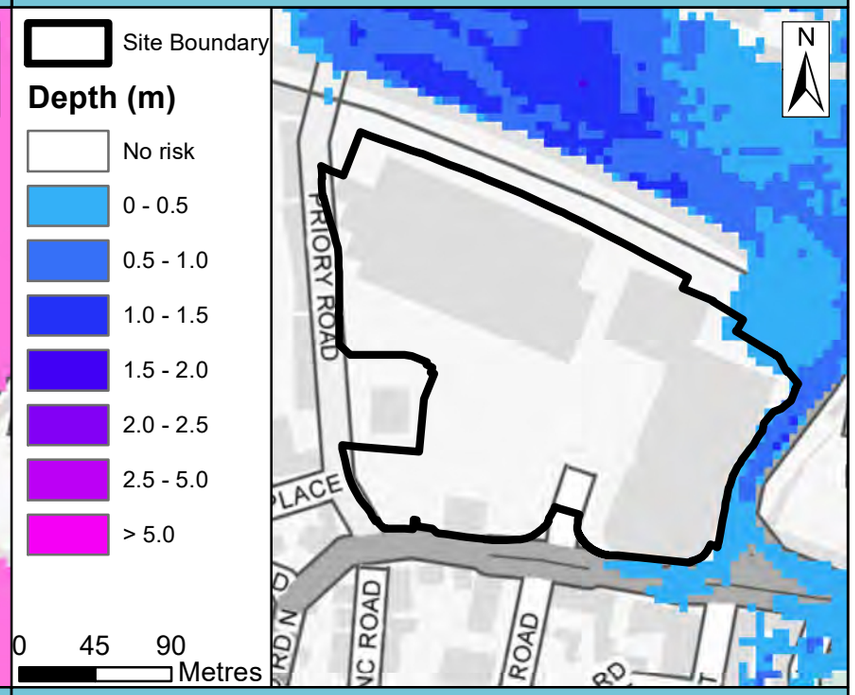

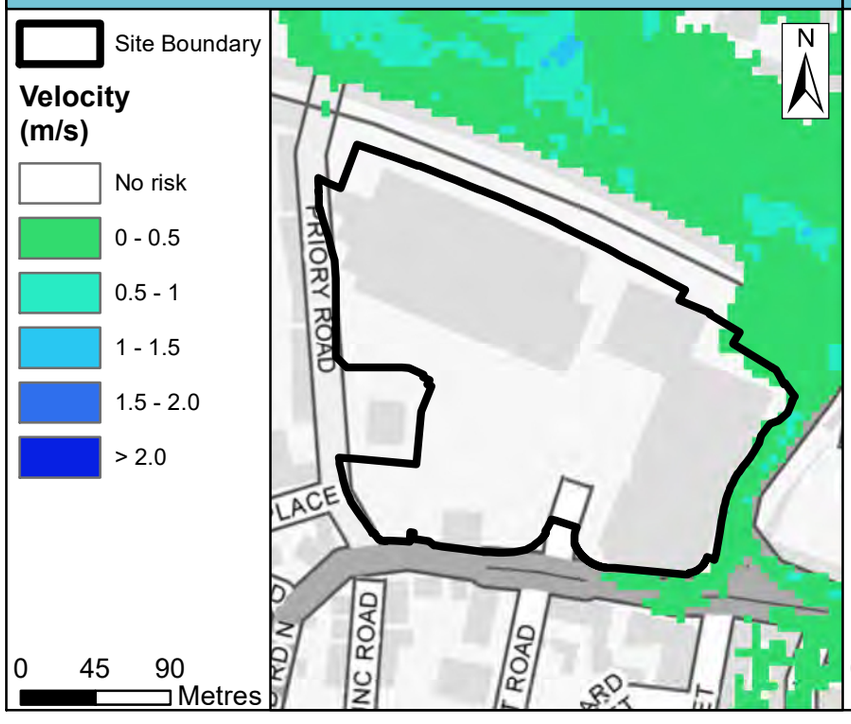

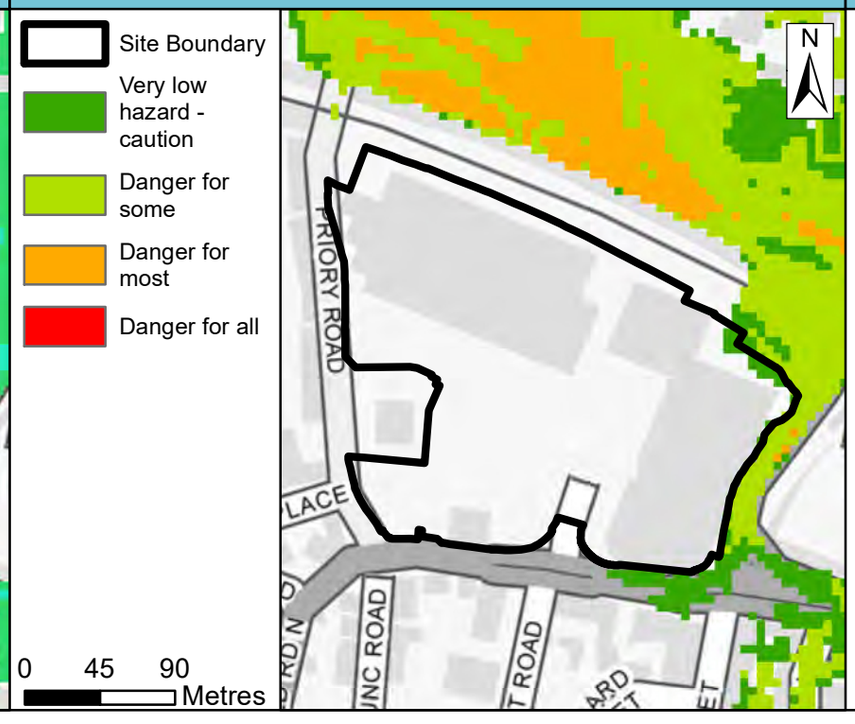

Site name	
Site area (ha)	3.1

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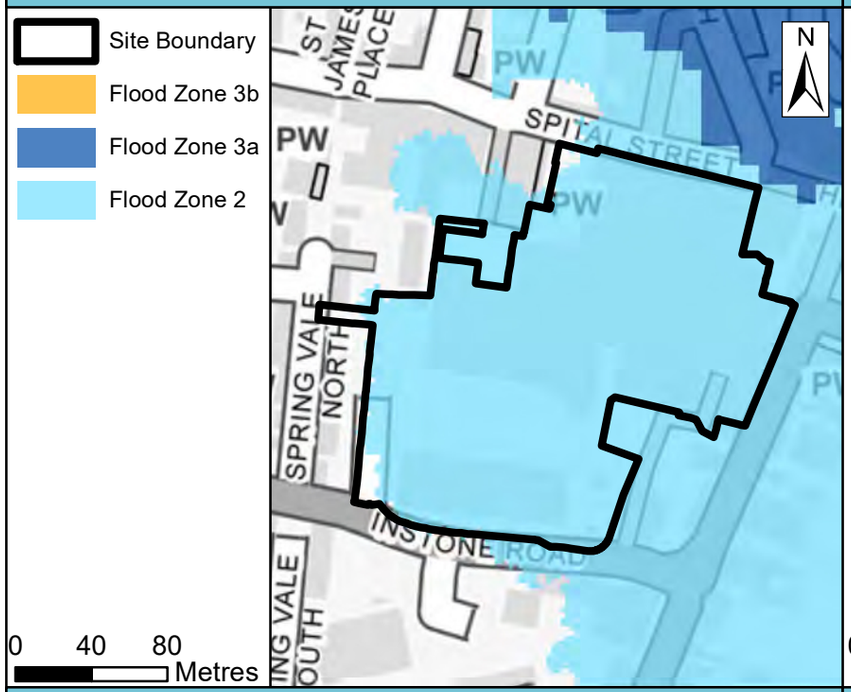

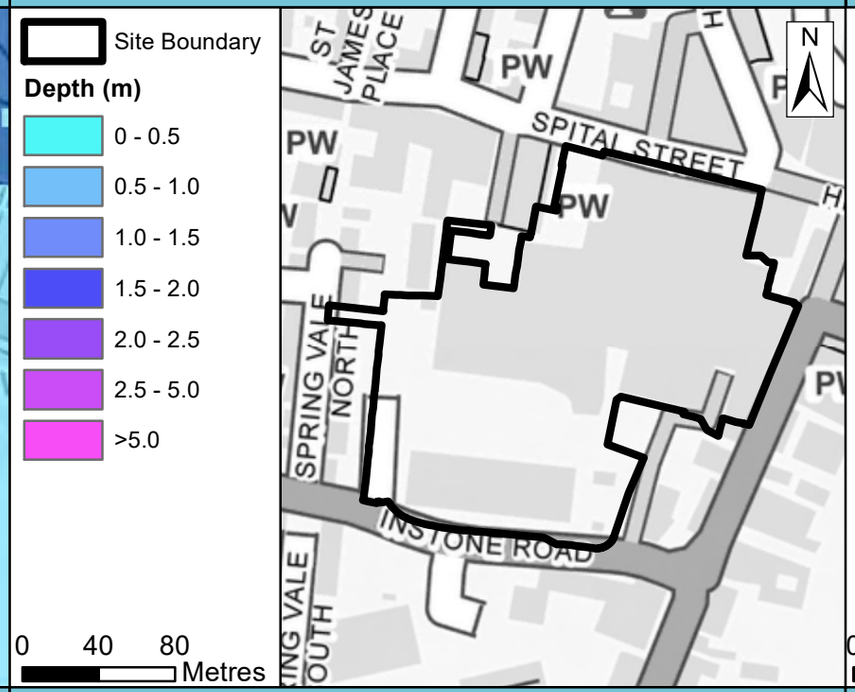

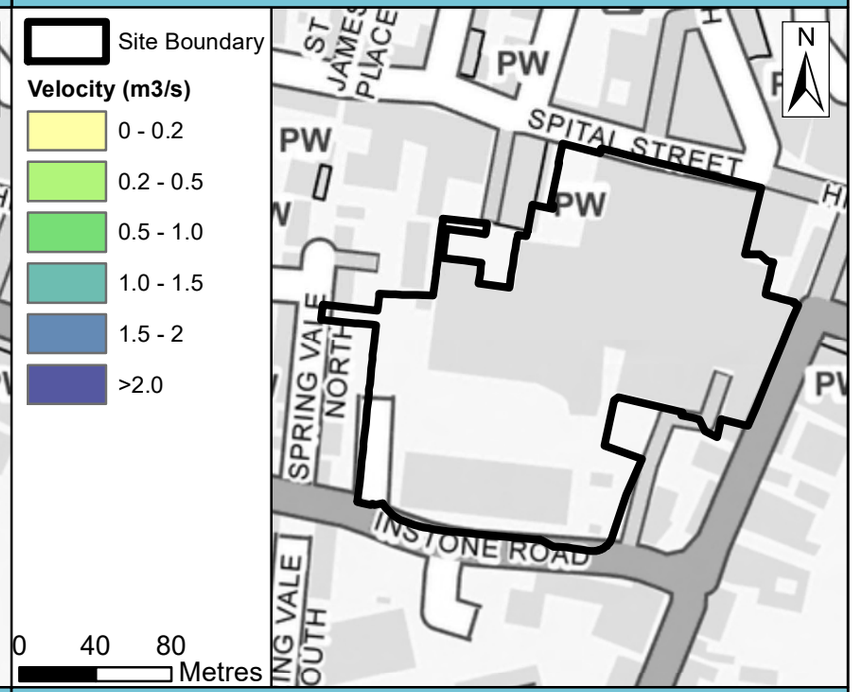

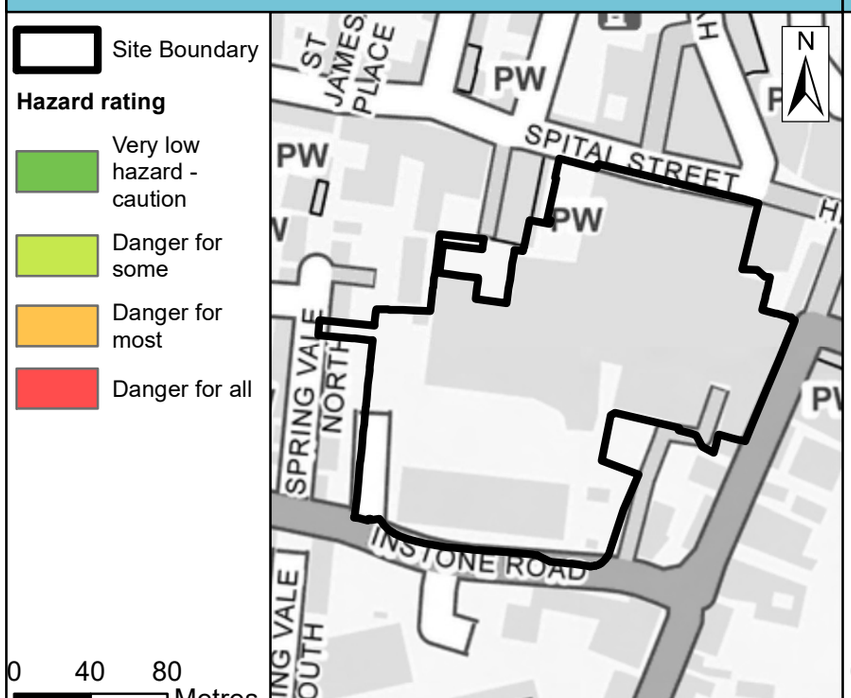

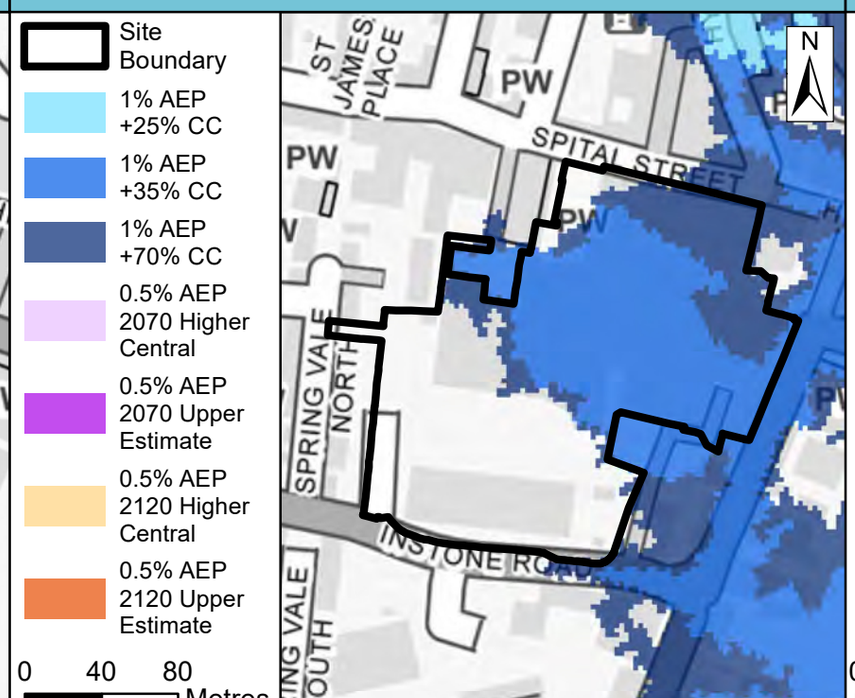

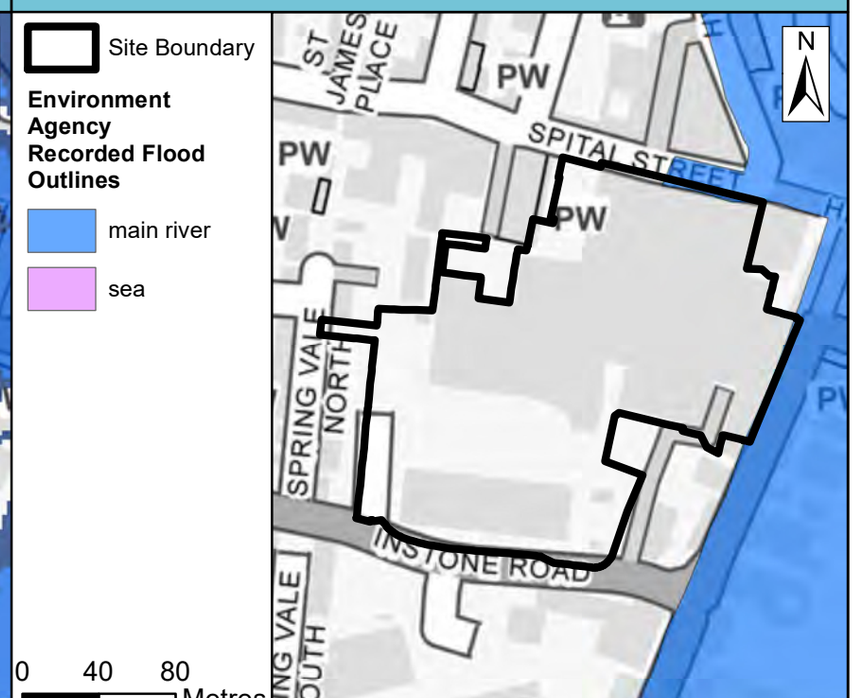

Site name	
Site area (ha)	3.1

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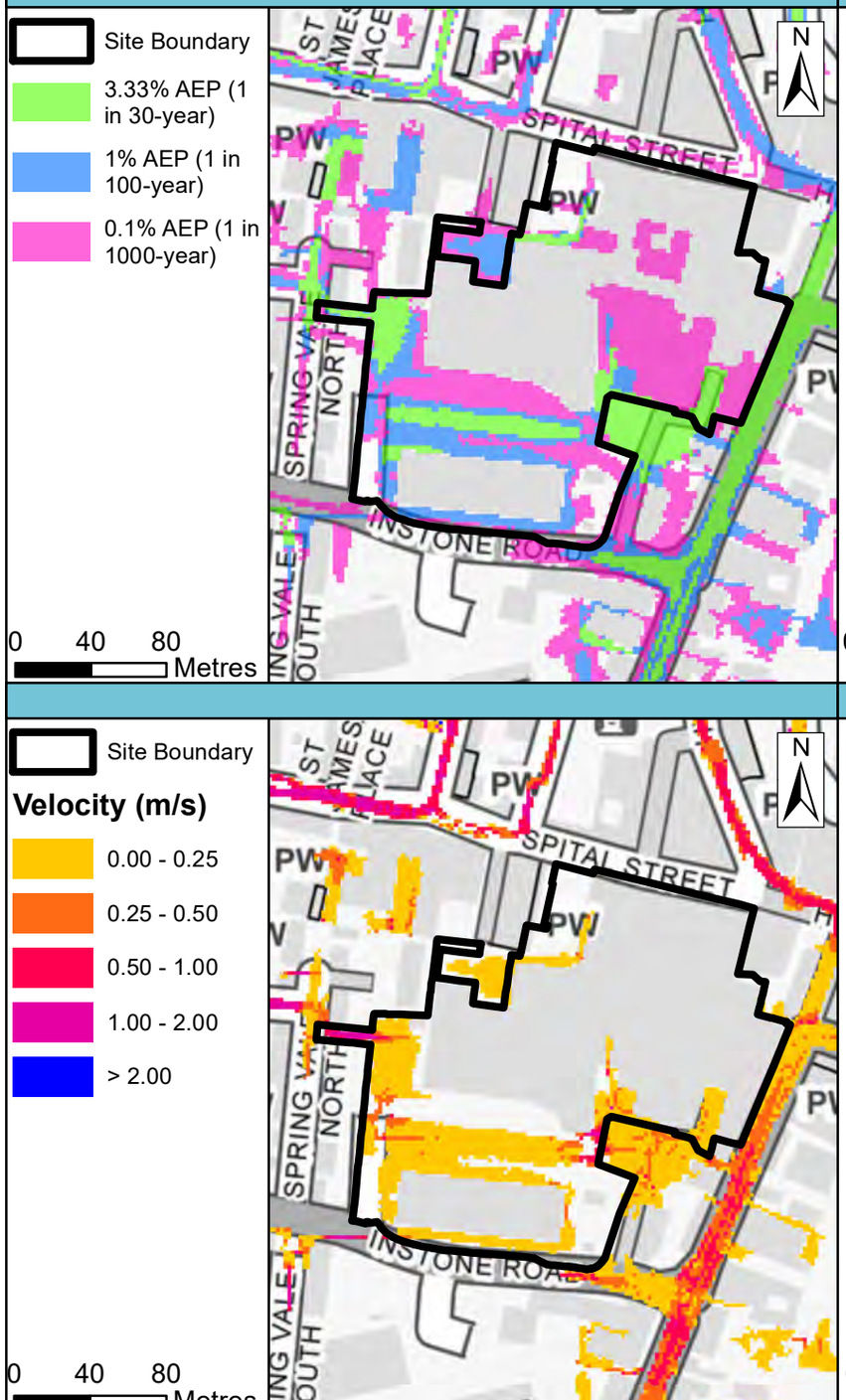

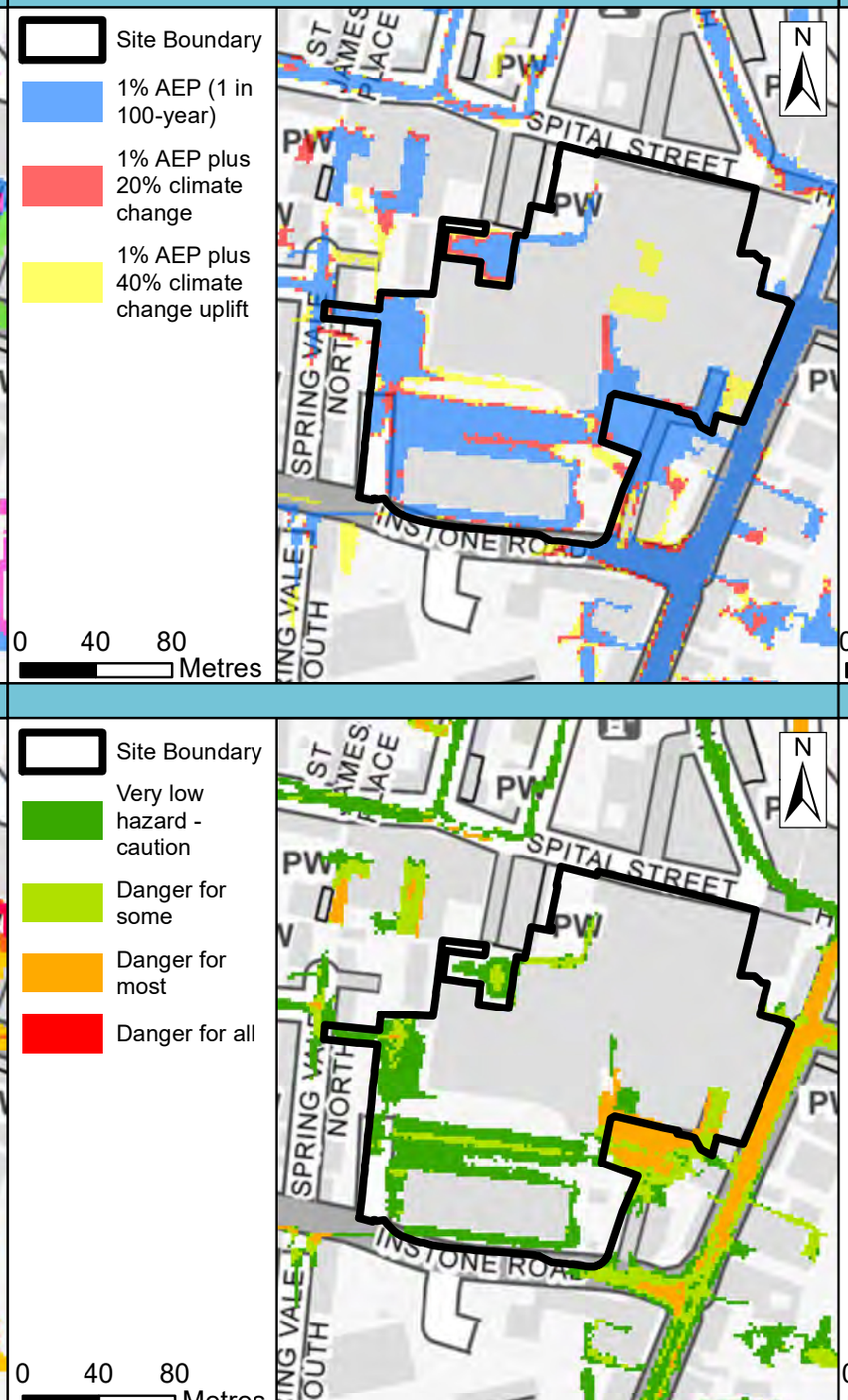

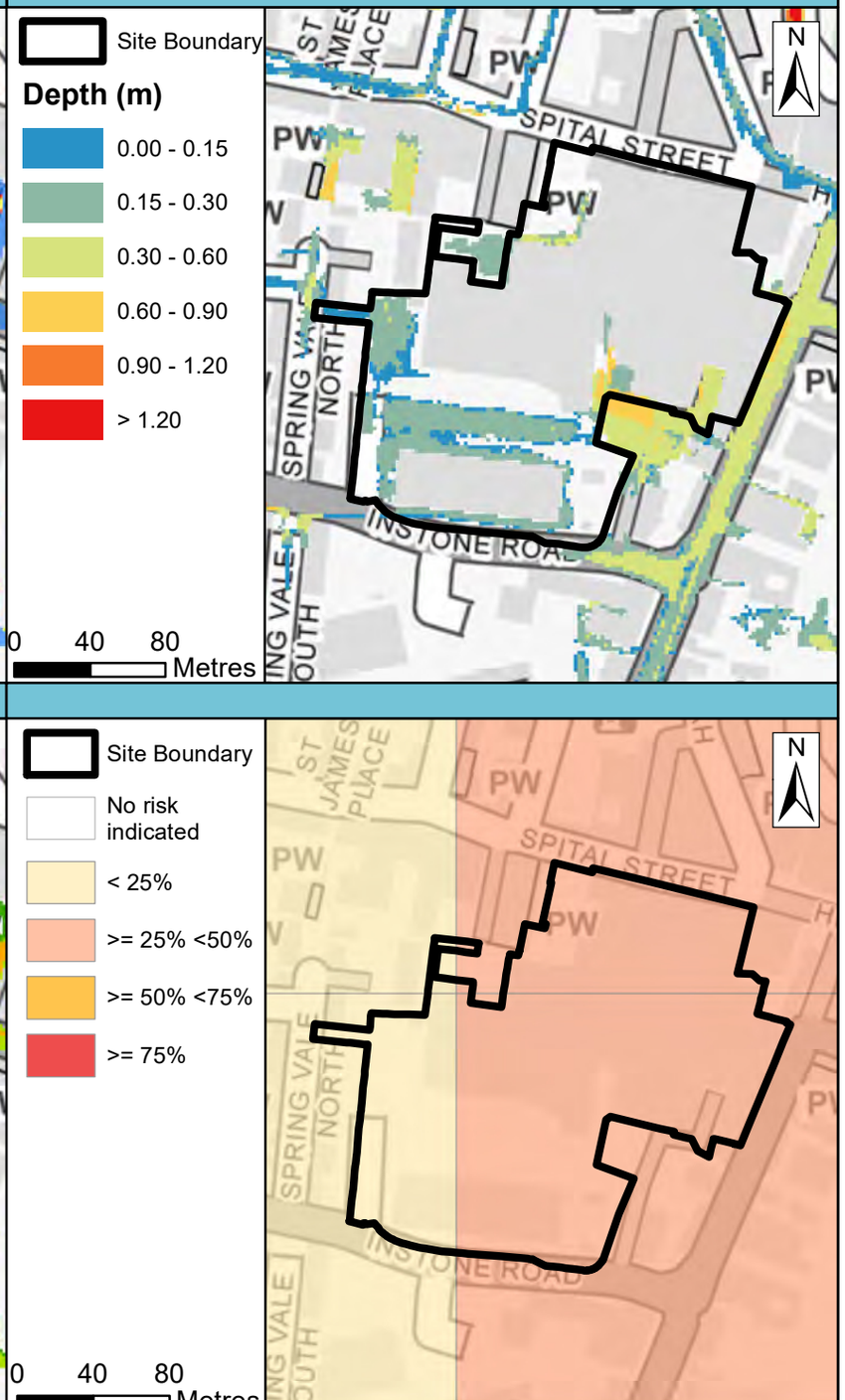

Site name			DARTFORD BOROUGH COUNCIL / JBA consulting
Site area (ha)	3.1		

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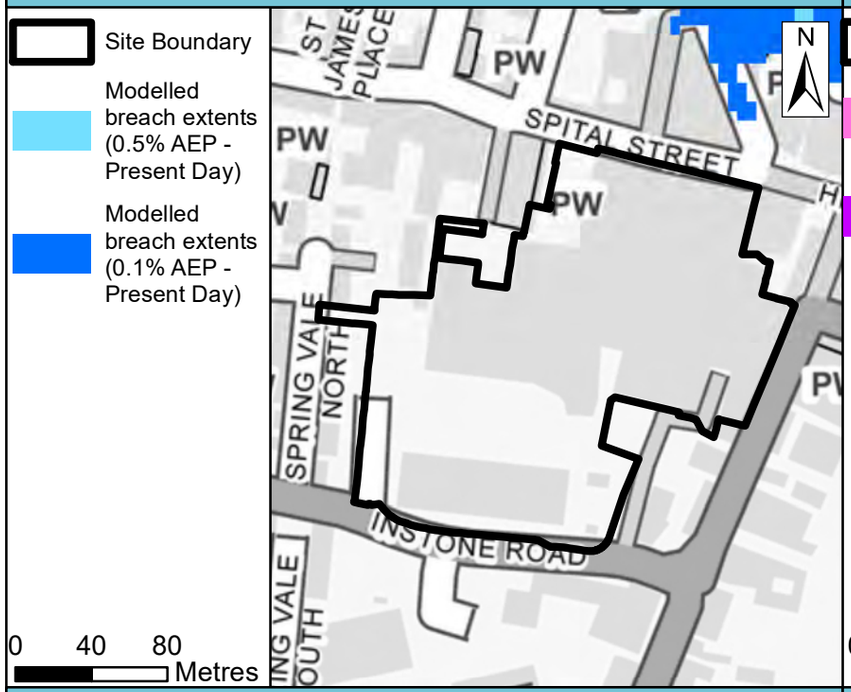

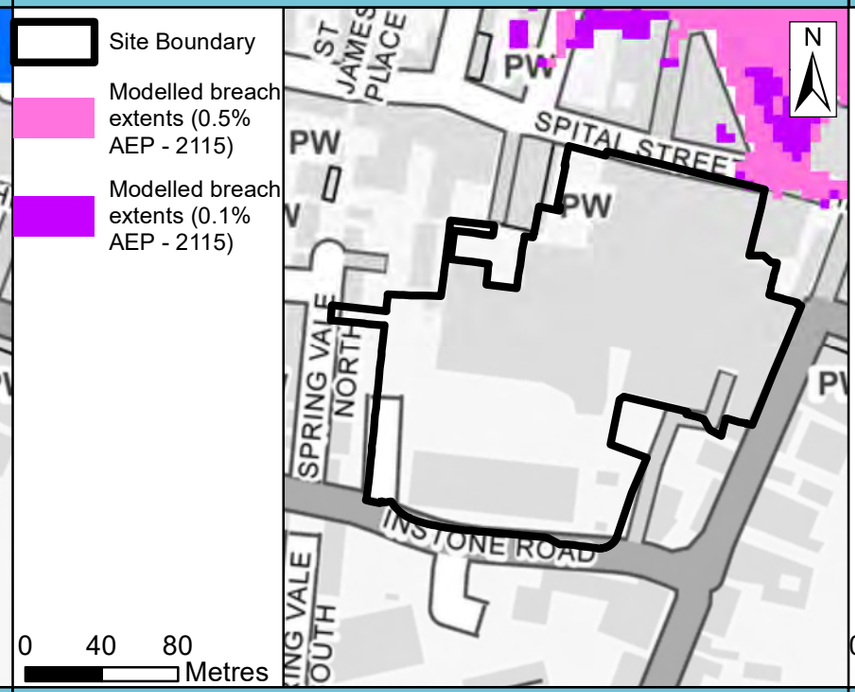

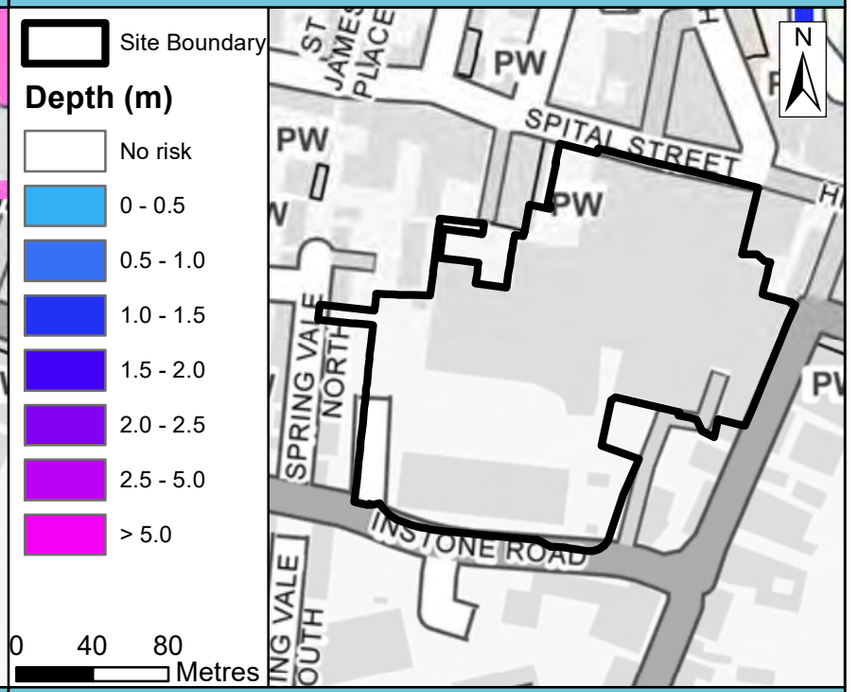

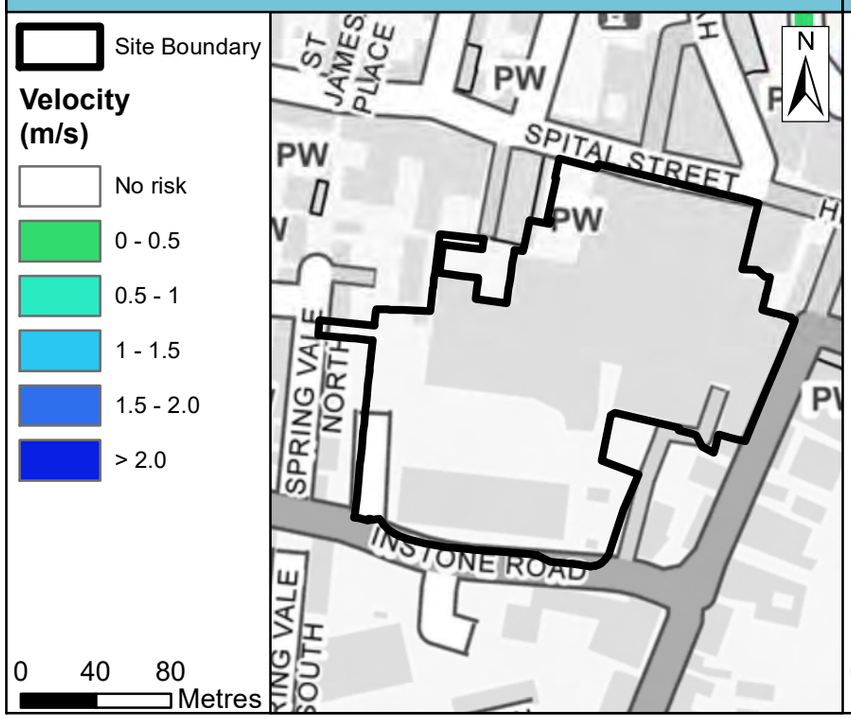

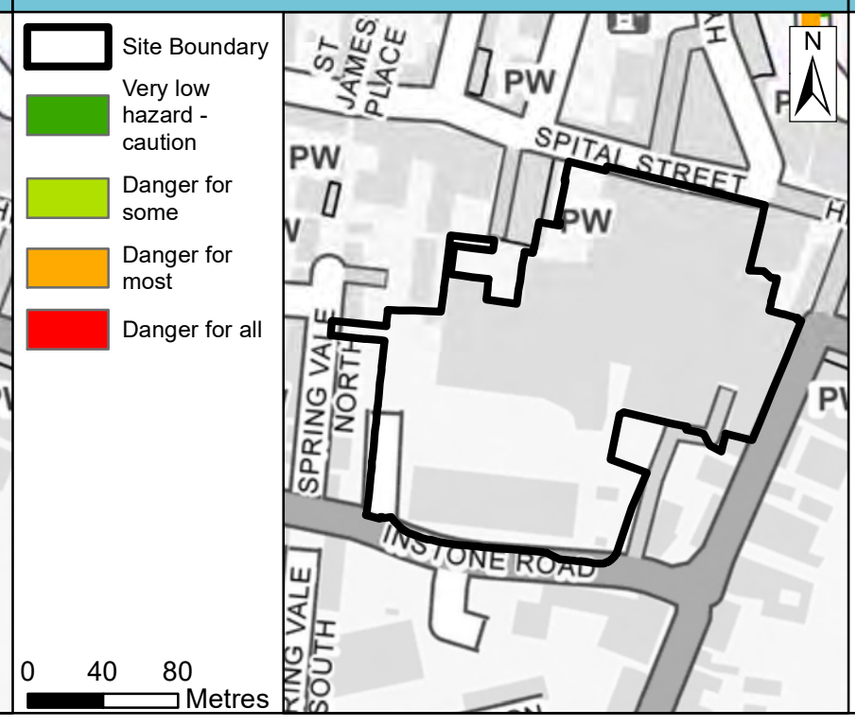

Site name	
Site area (ha)	4.4

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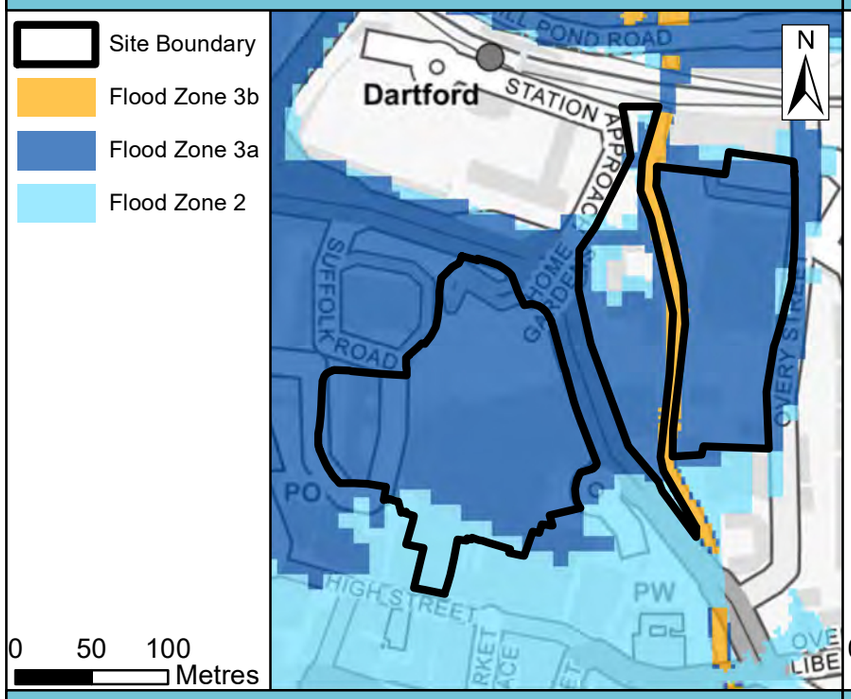

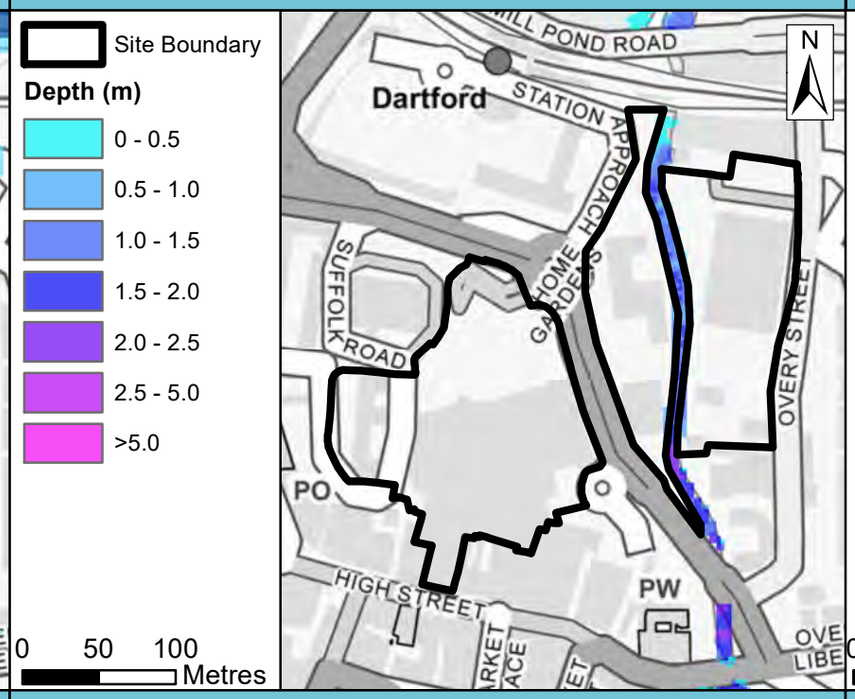

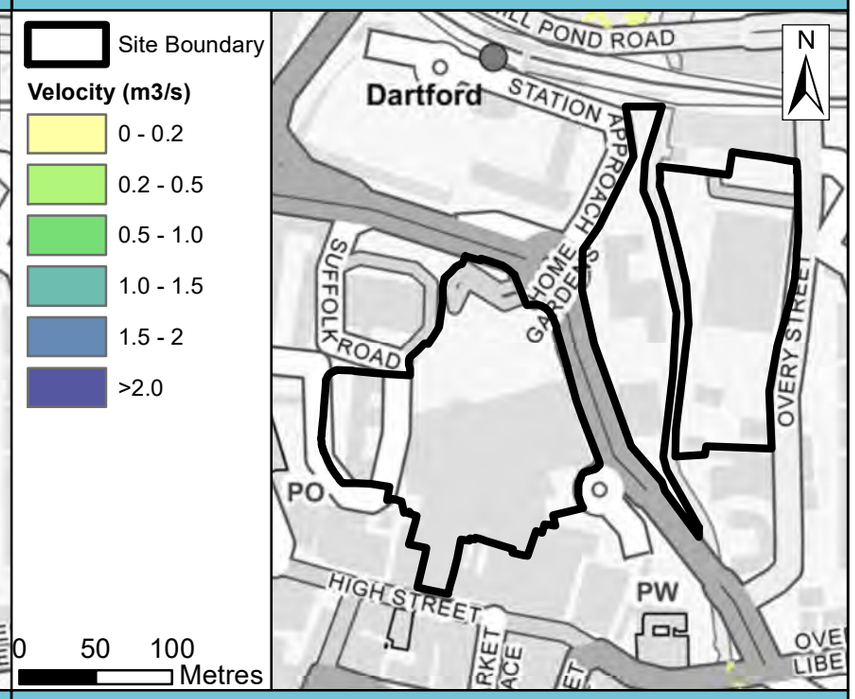

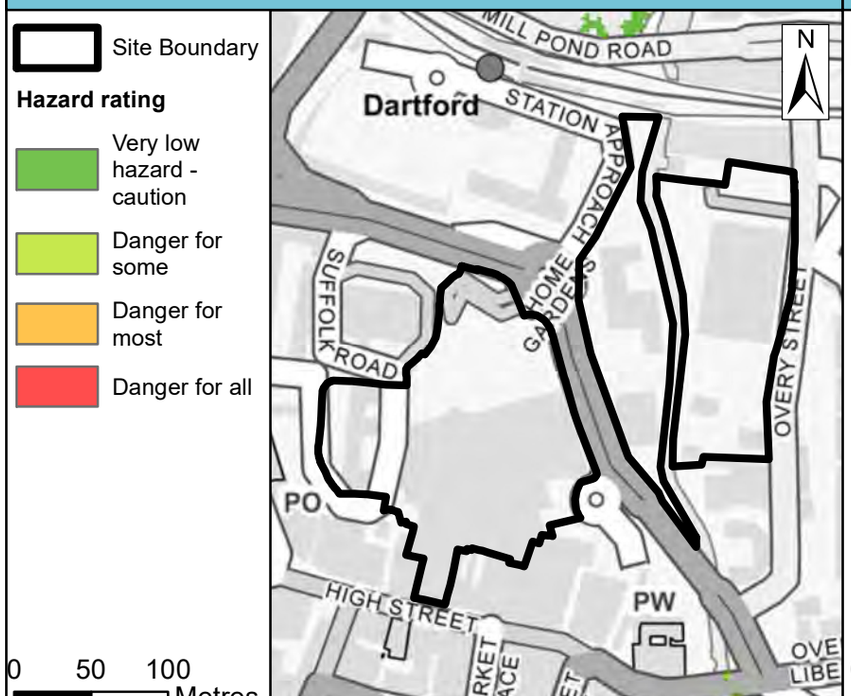

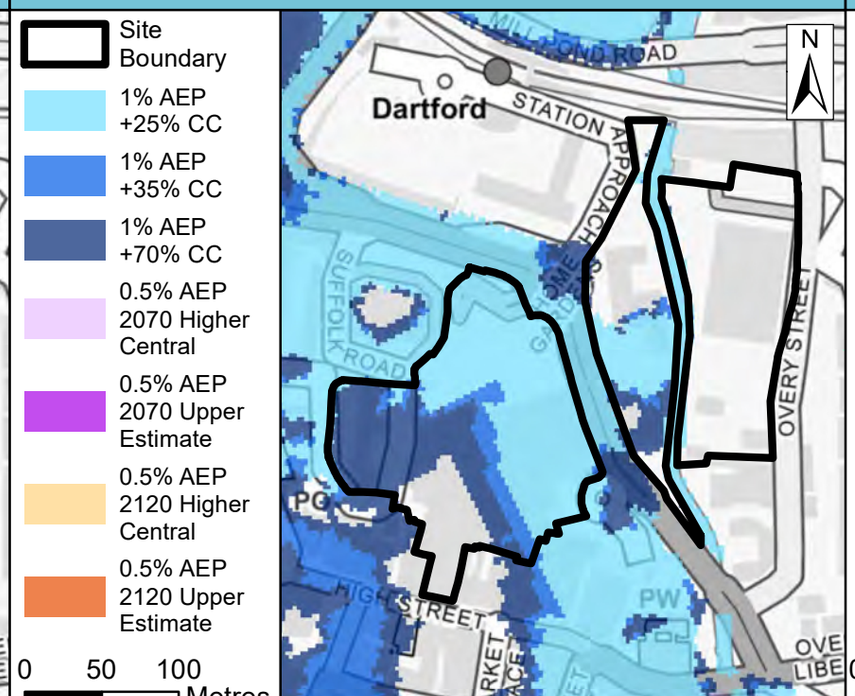

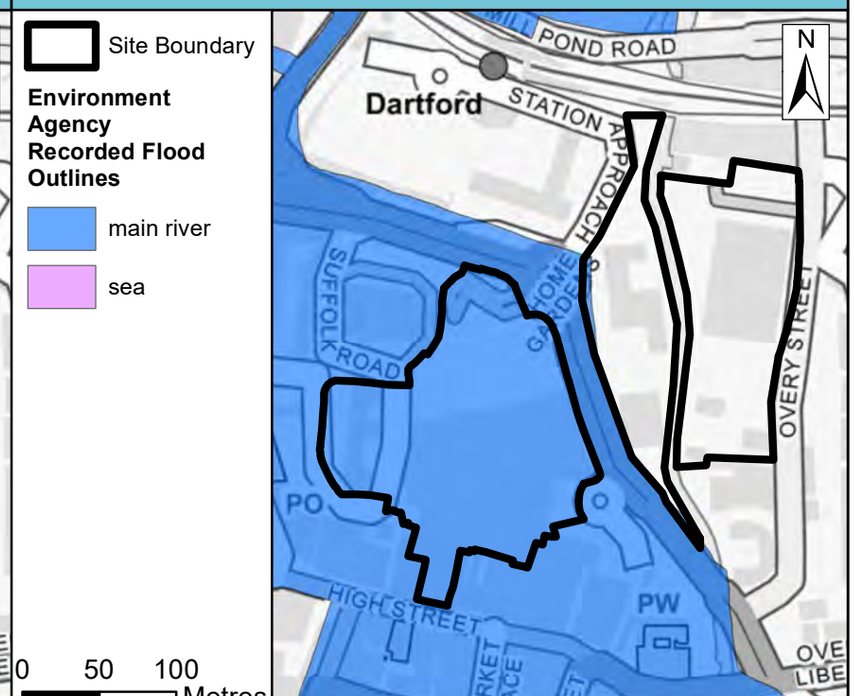

Site name	
Site area (ha)	4.4

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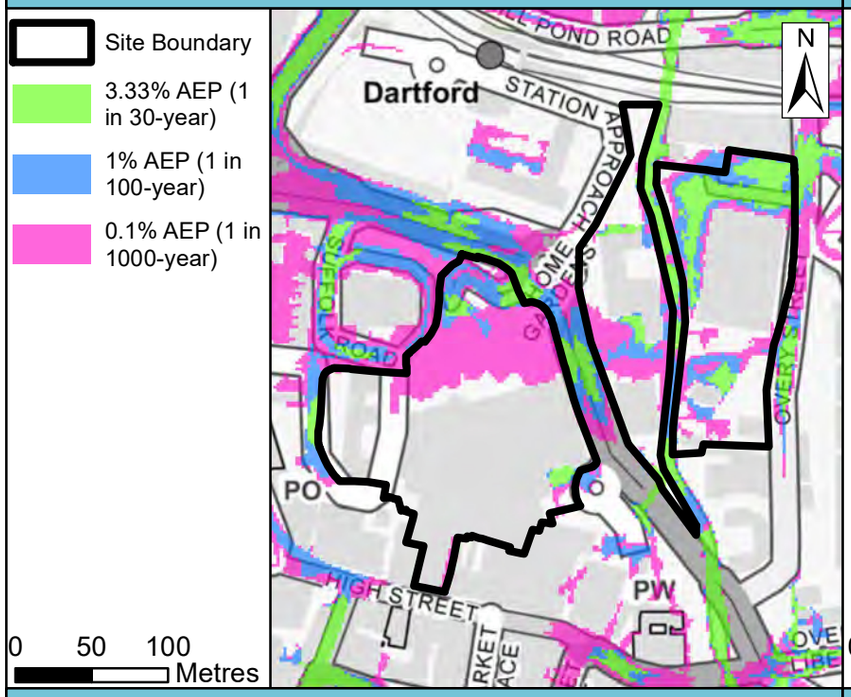

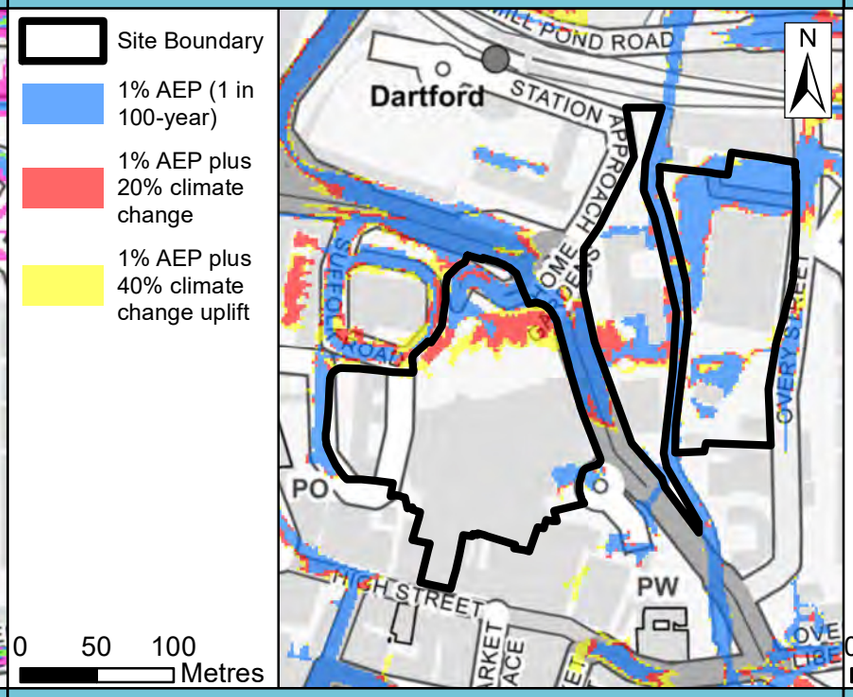

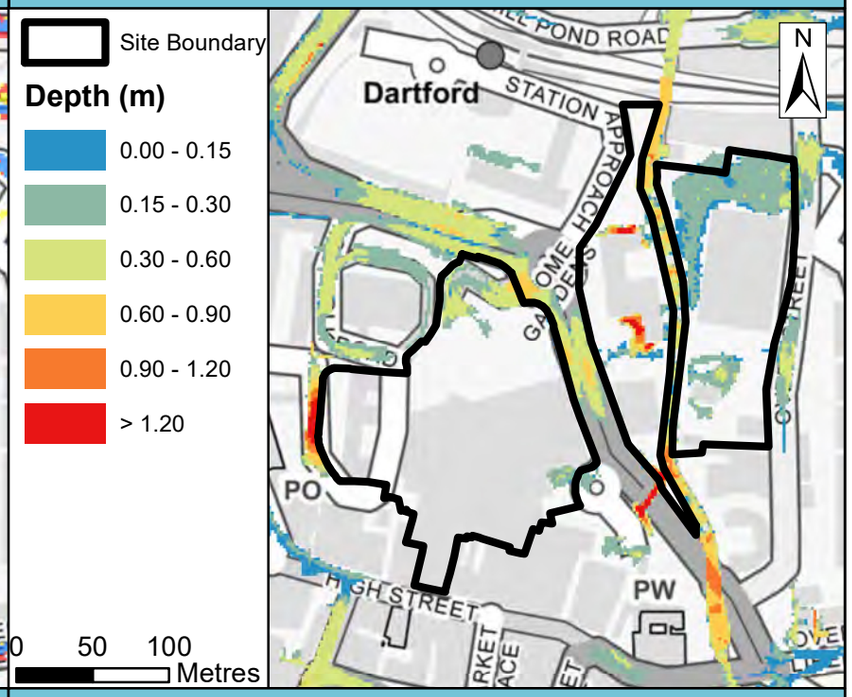

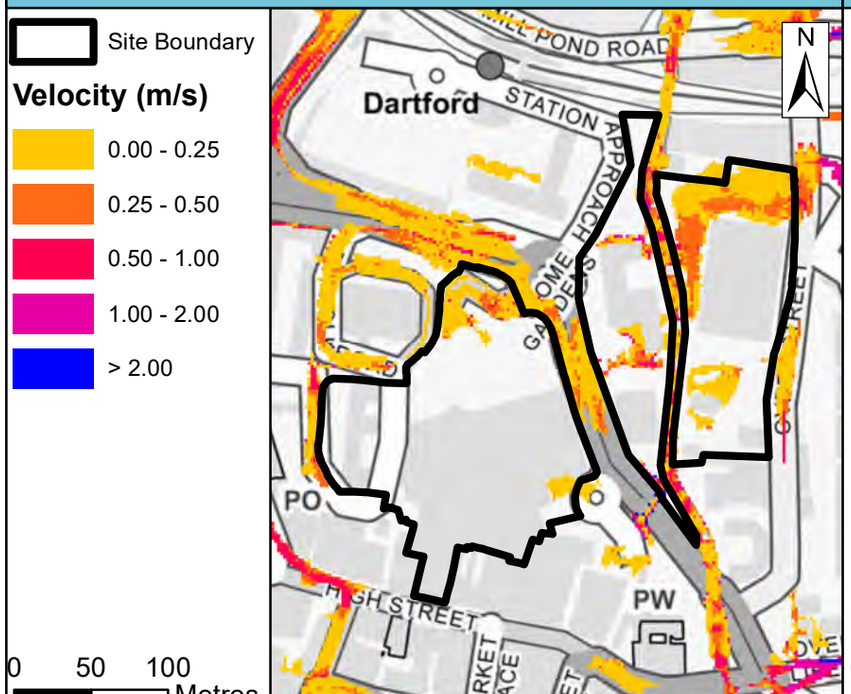

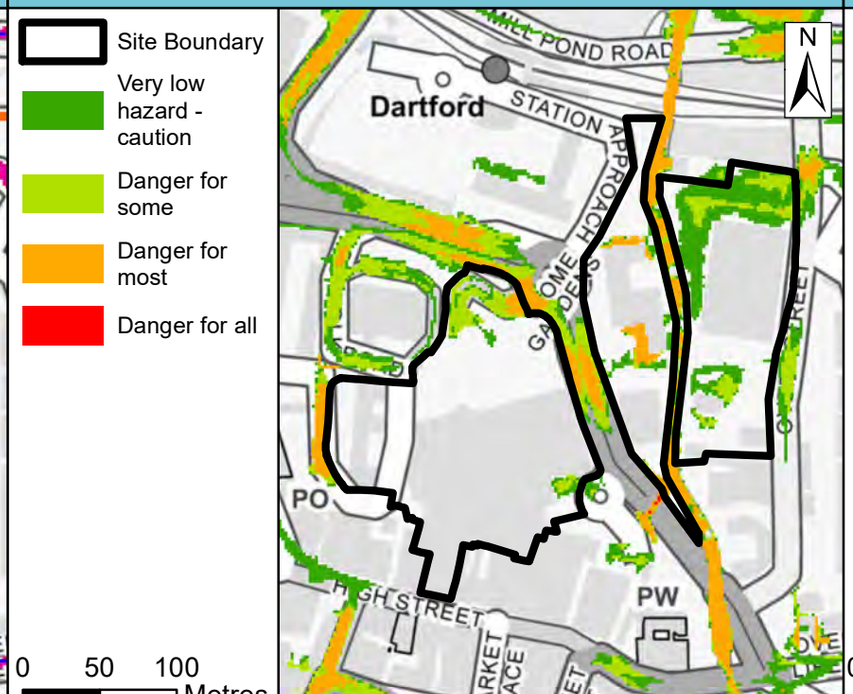

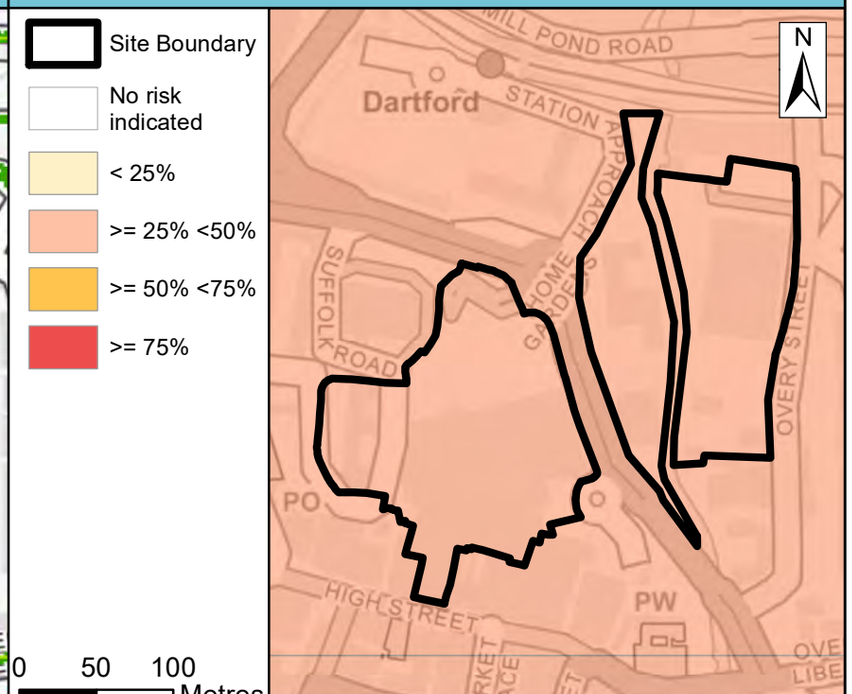

Site name		
Site area (ha)	4.4	

DARTFORD BOROUGH COUNCIL

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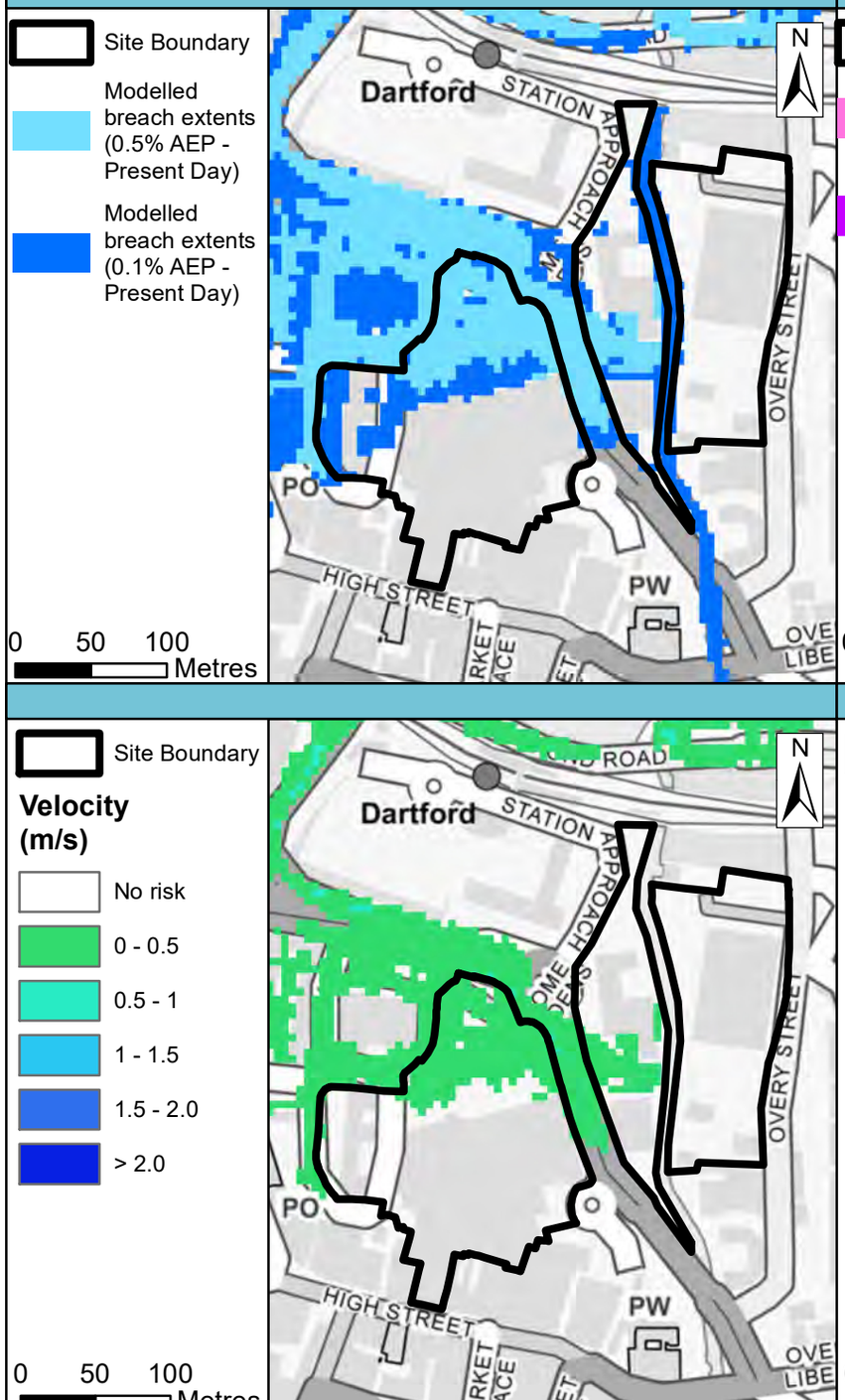

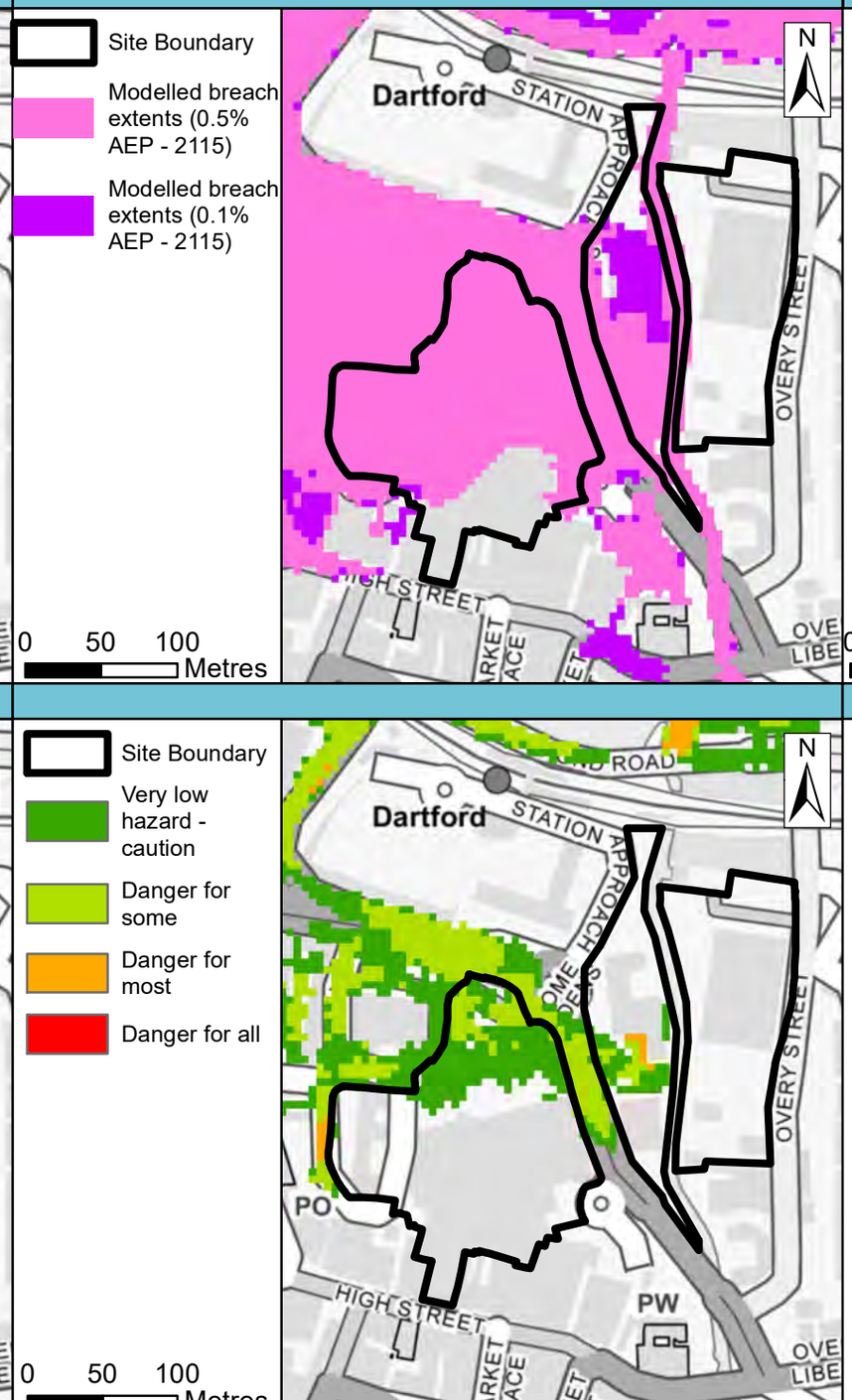

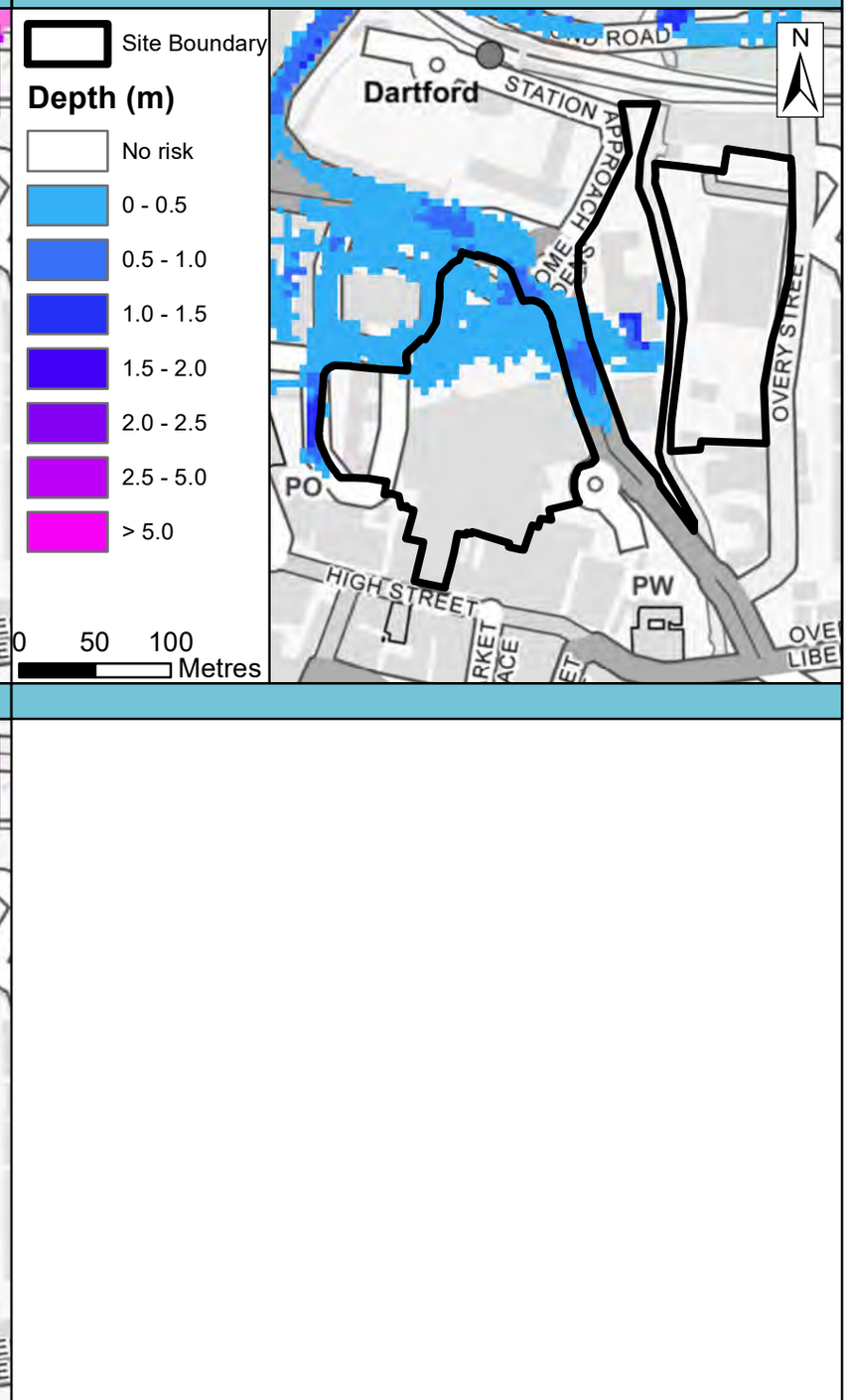

Site name	
Site area (ha)	0.27

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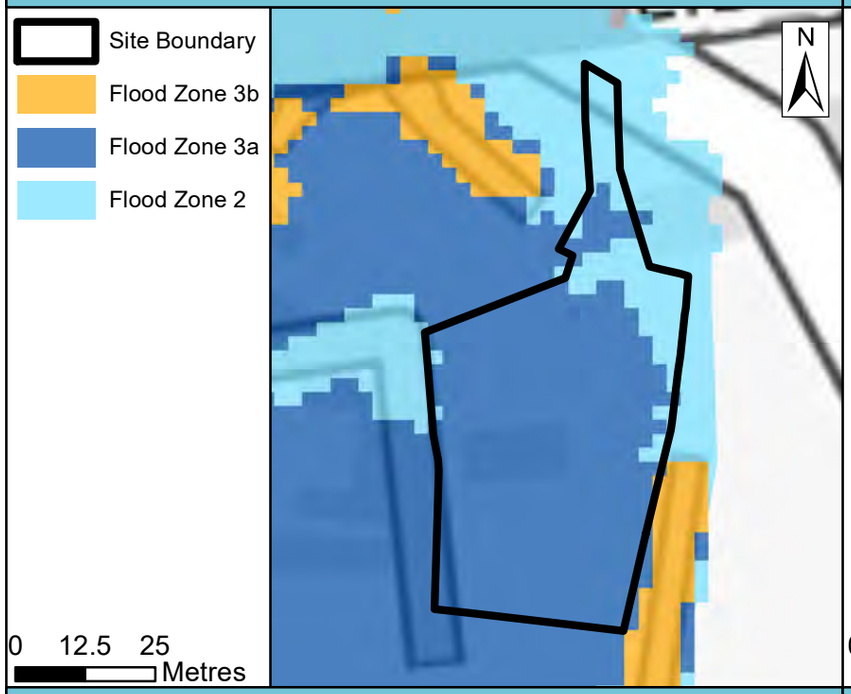

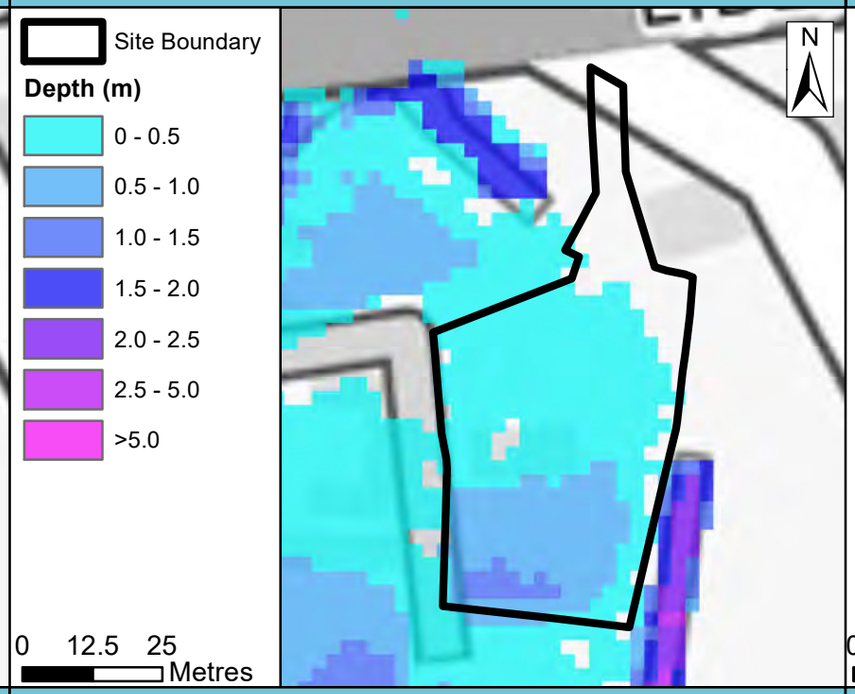

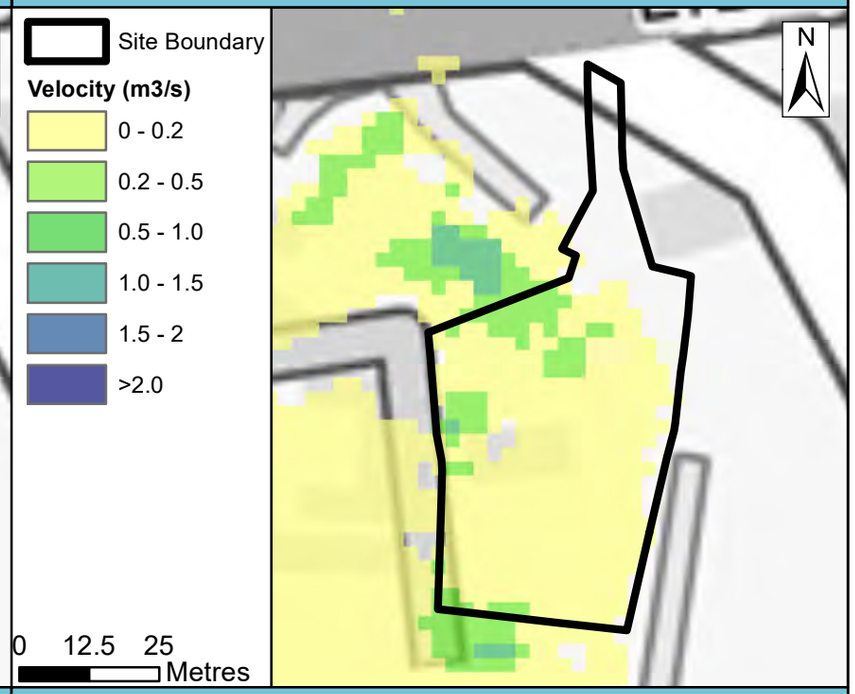

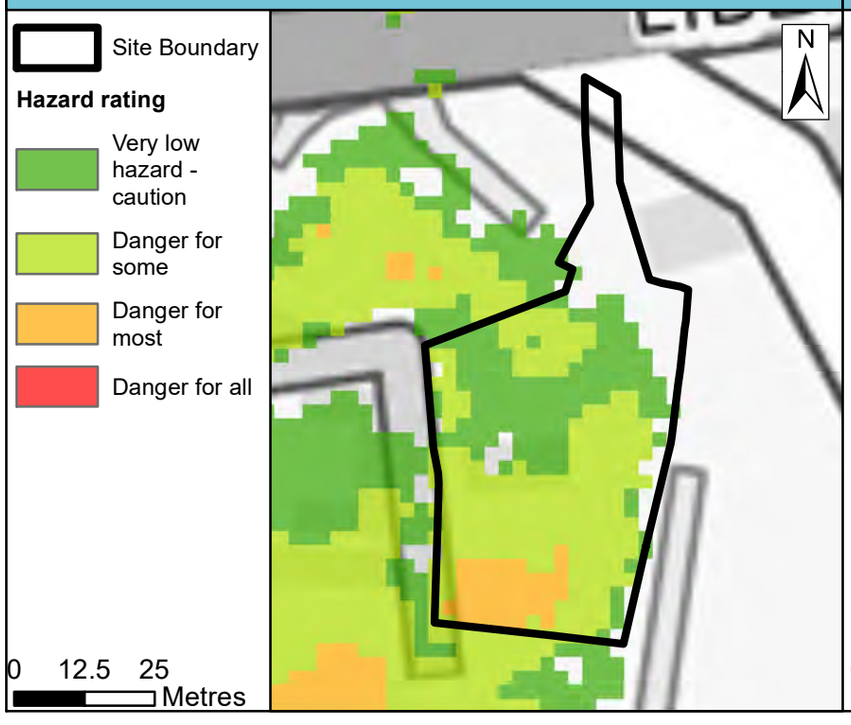

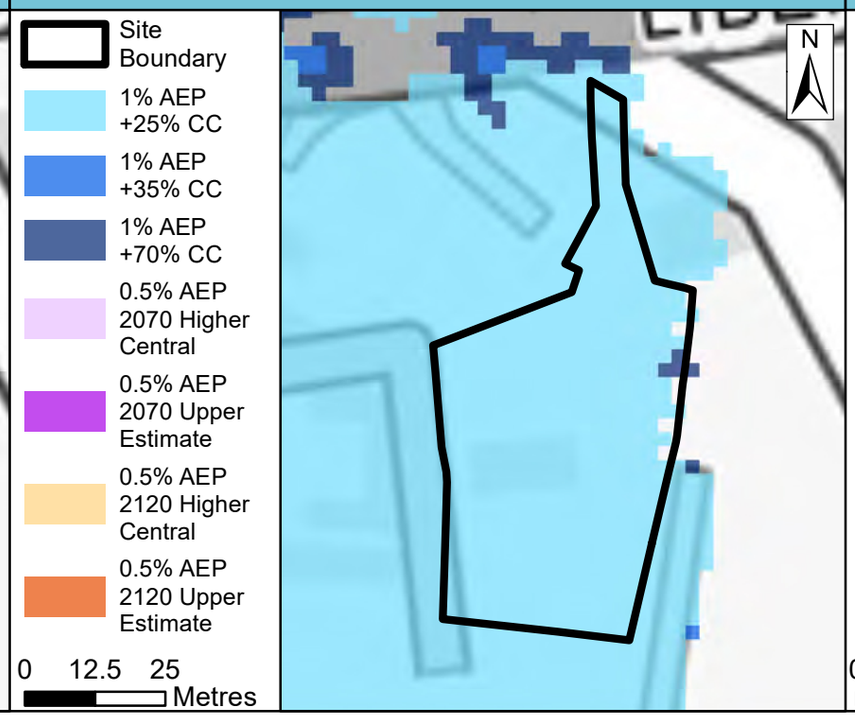

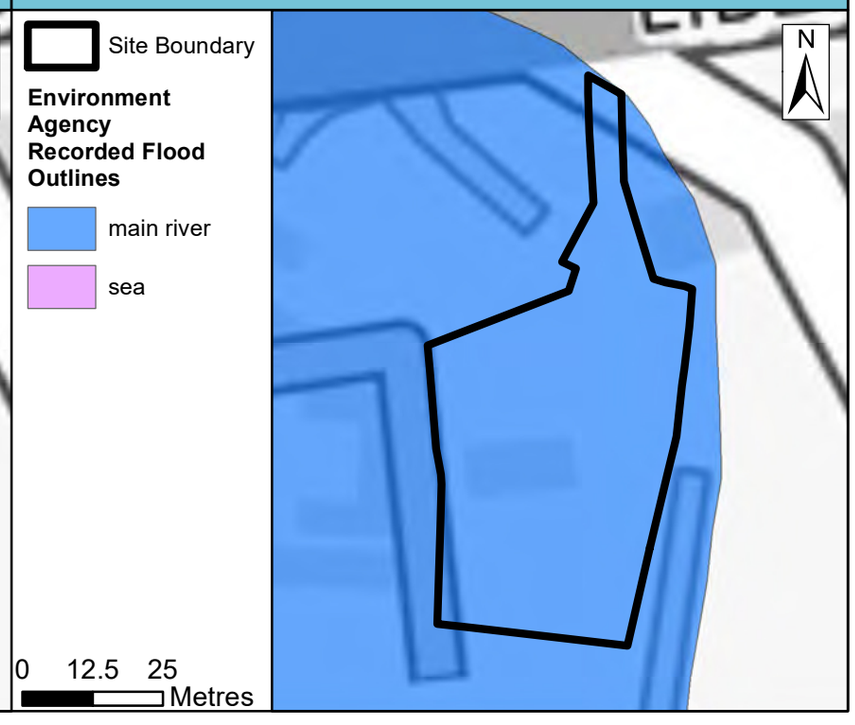

Site name	
Site area (ha)	0.27

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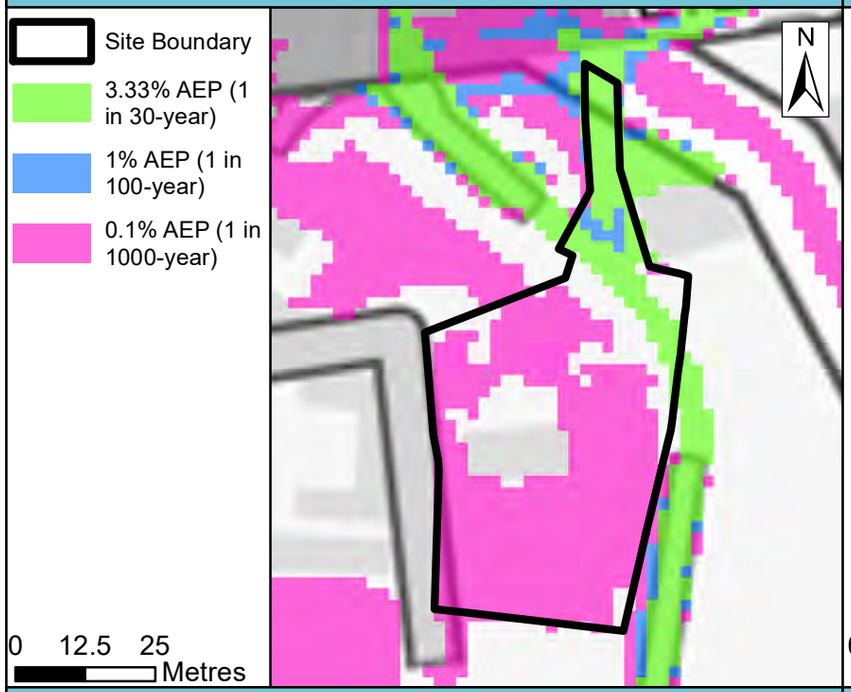

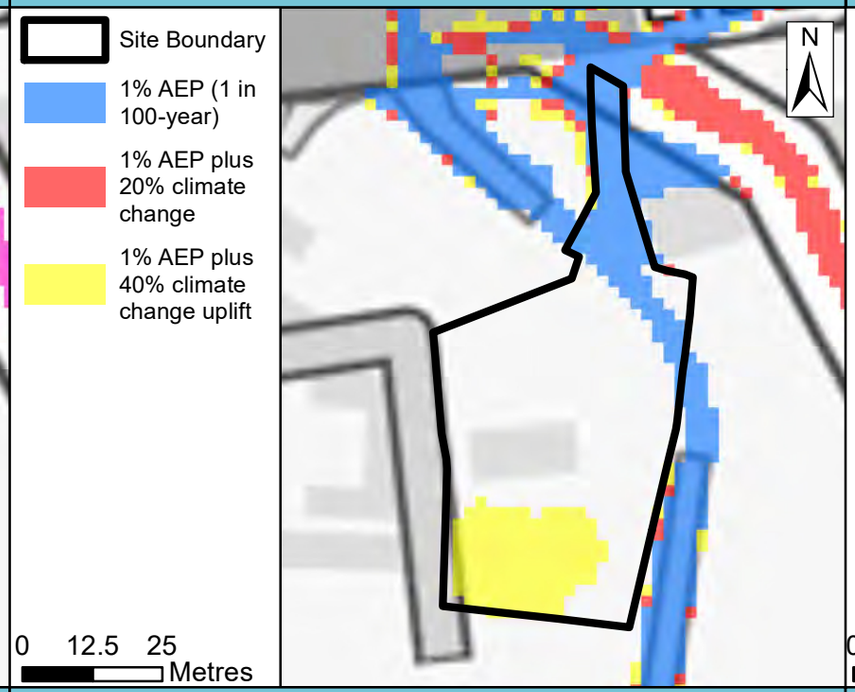

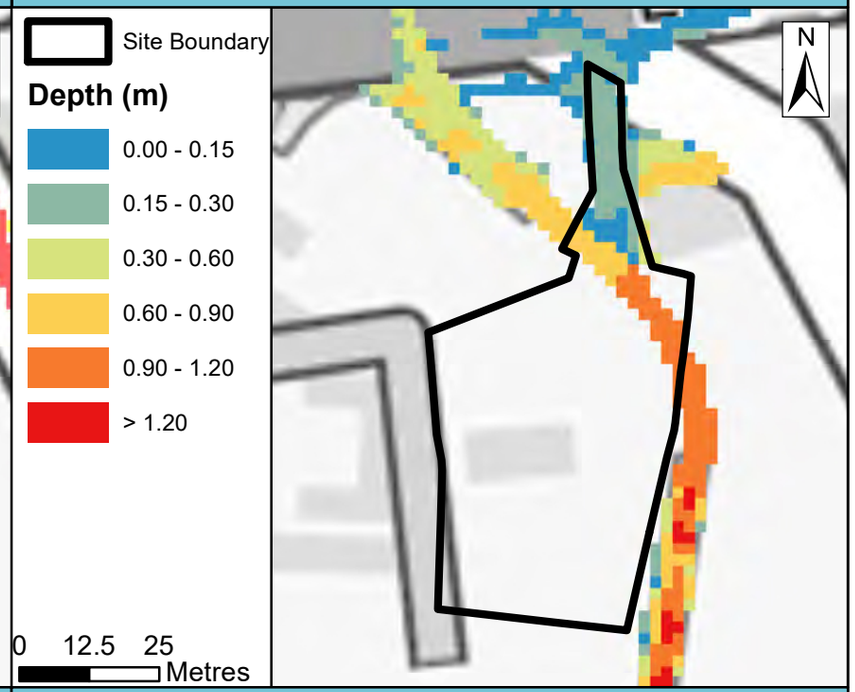

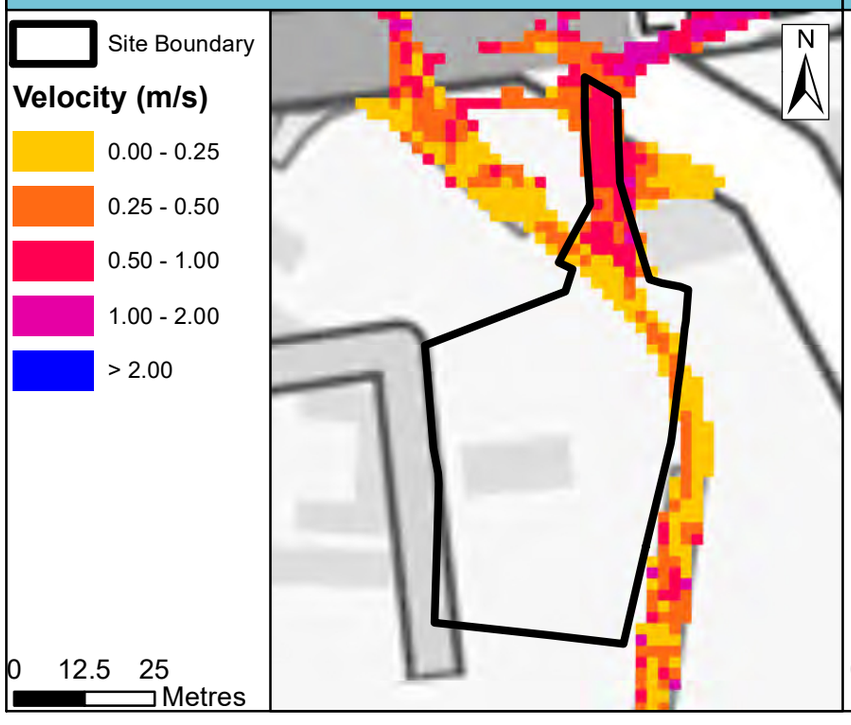

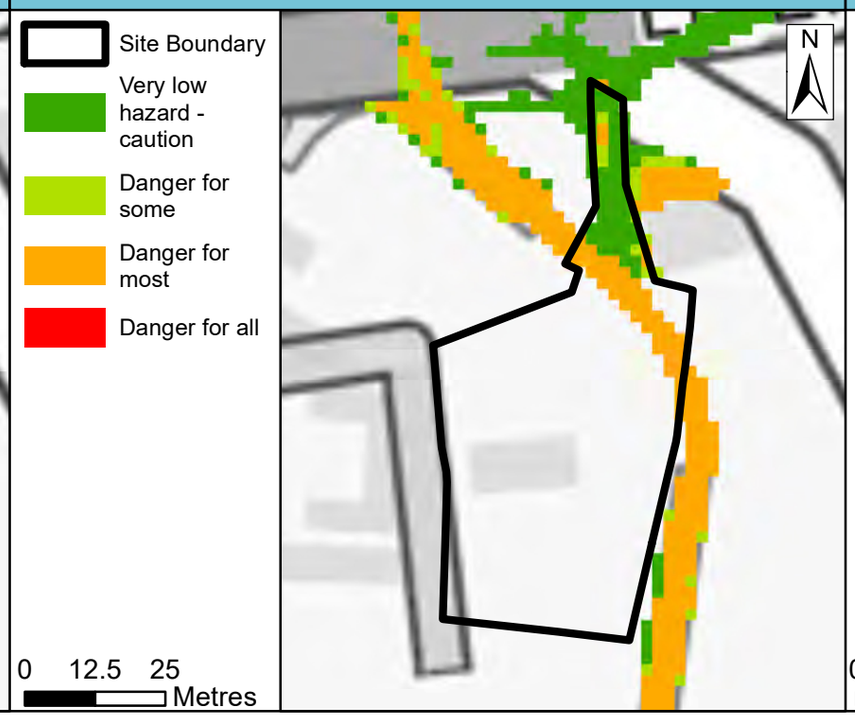

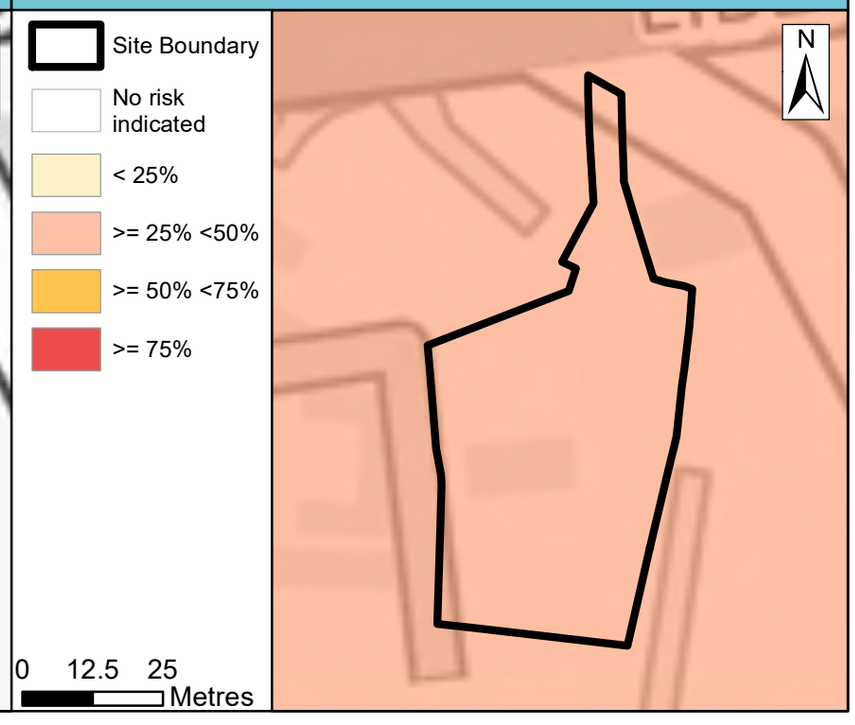

Site name	
Site area (ha)	0.27

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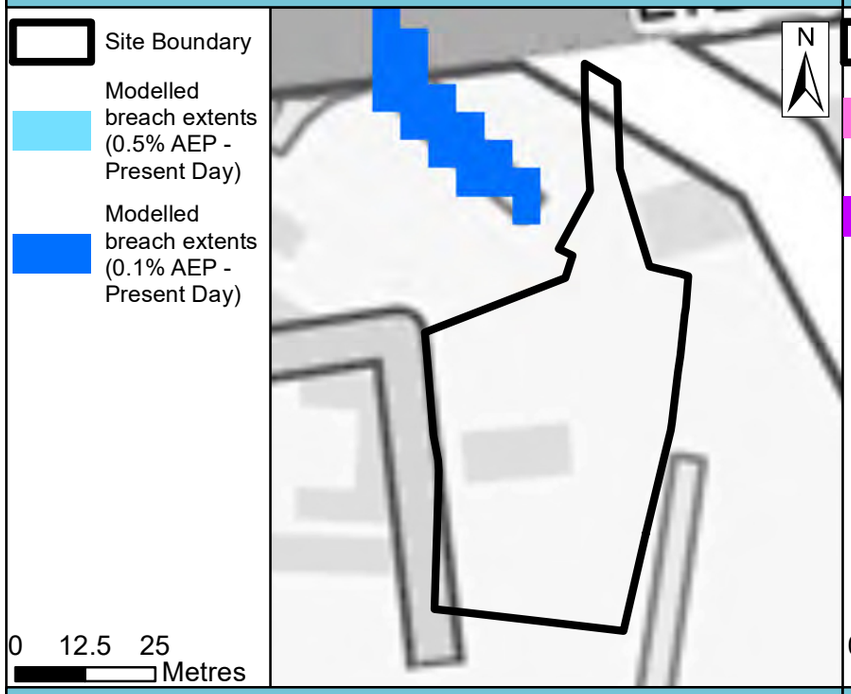

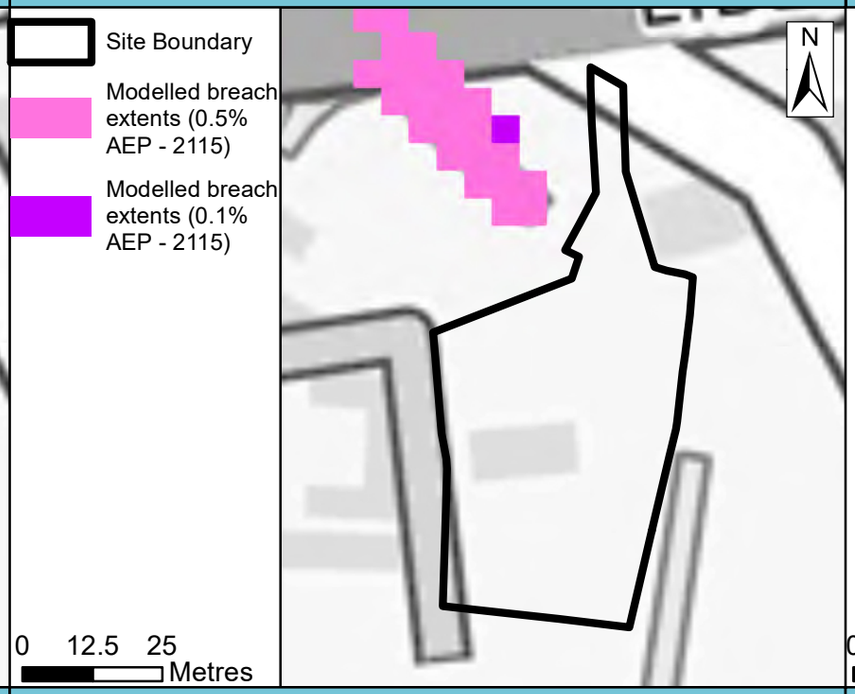

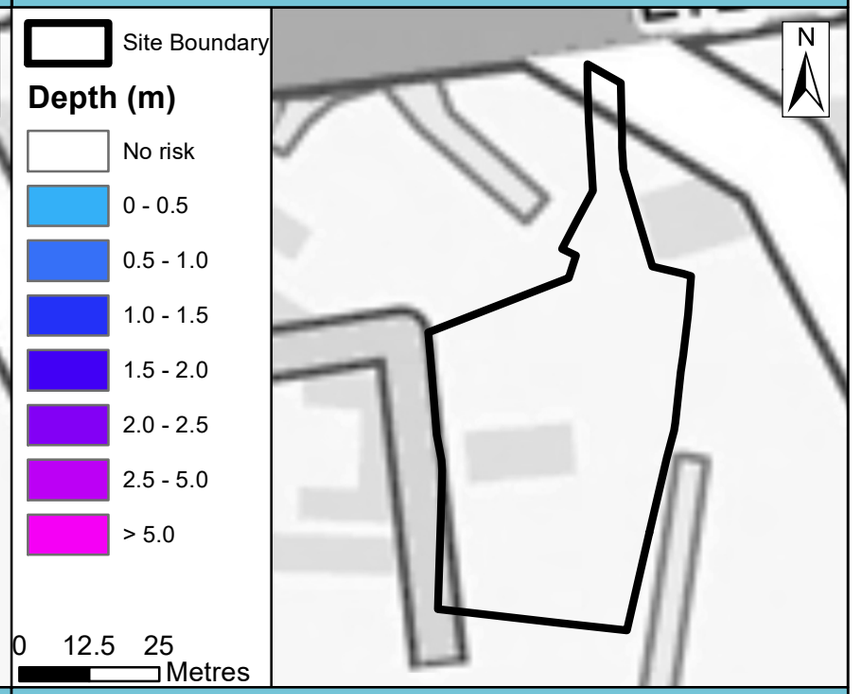

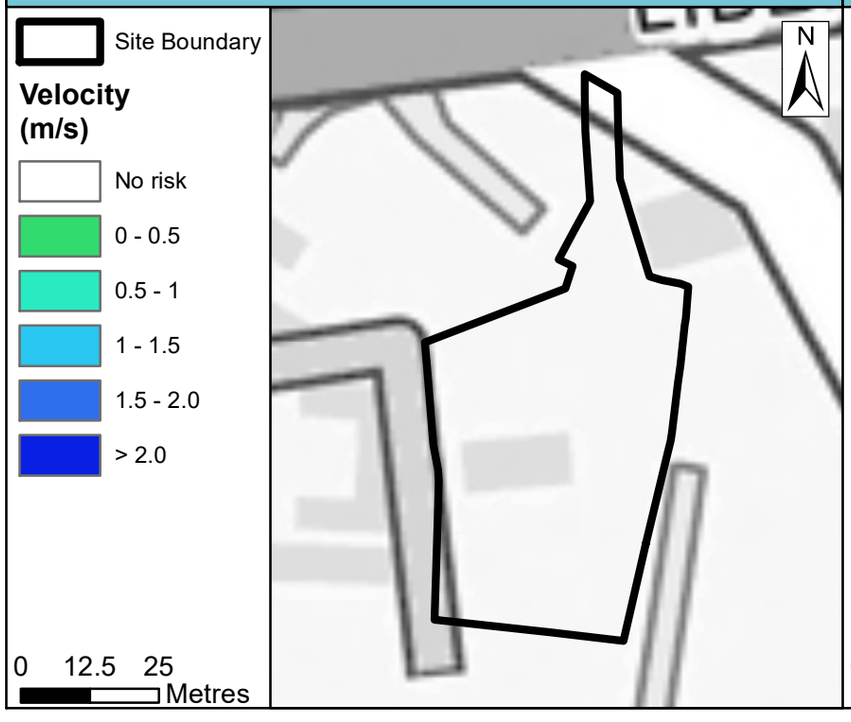

Site name	
Site area (ha)	0.67

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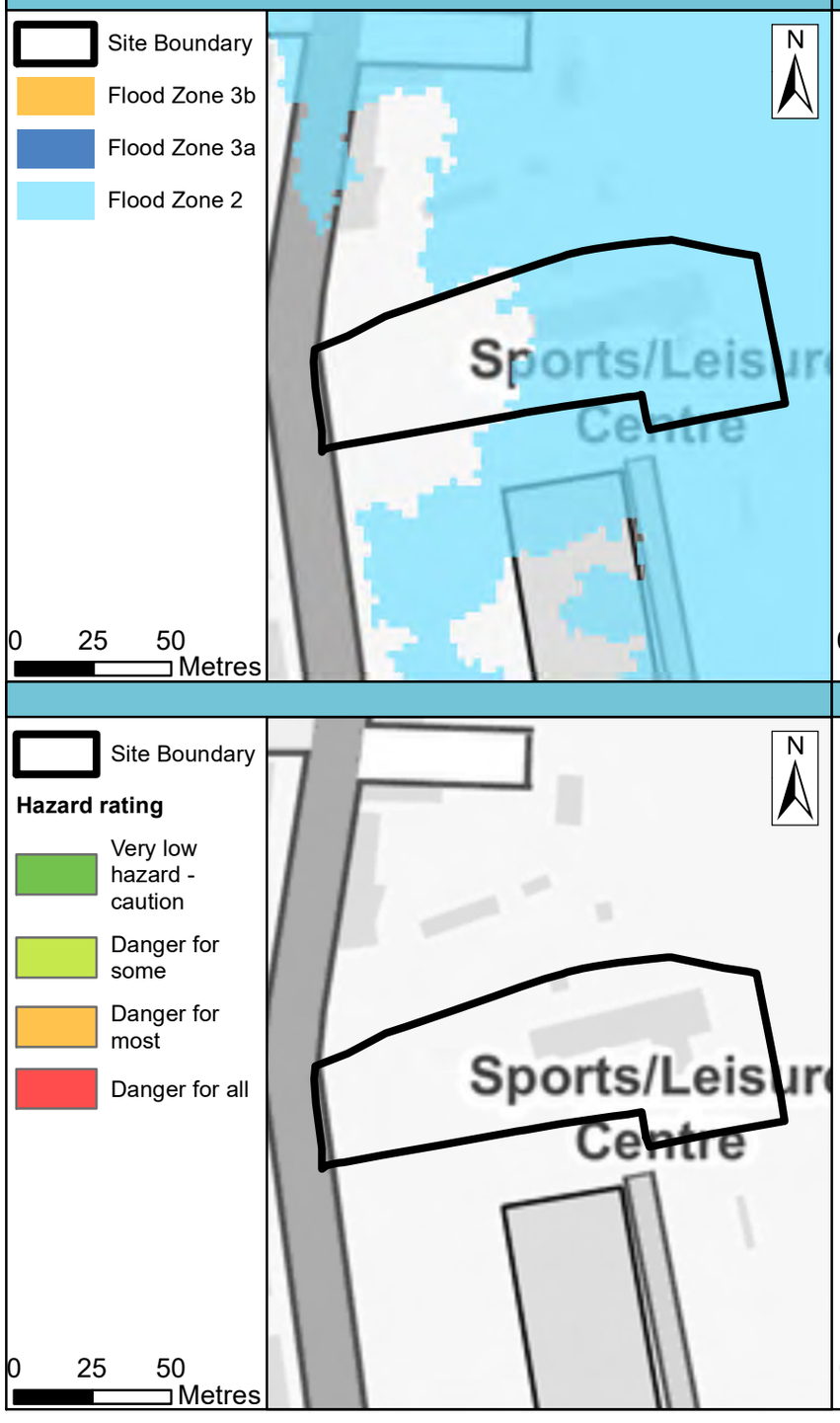

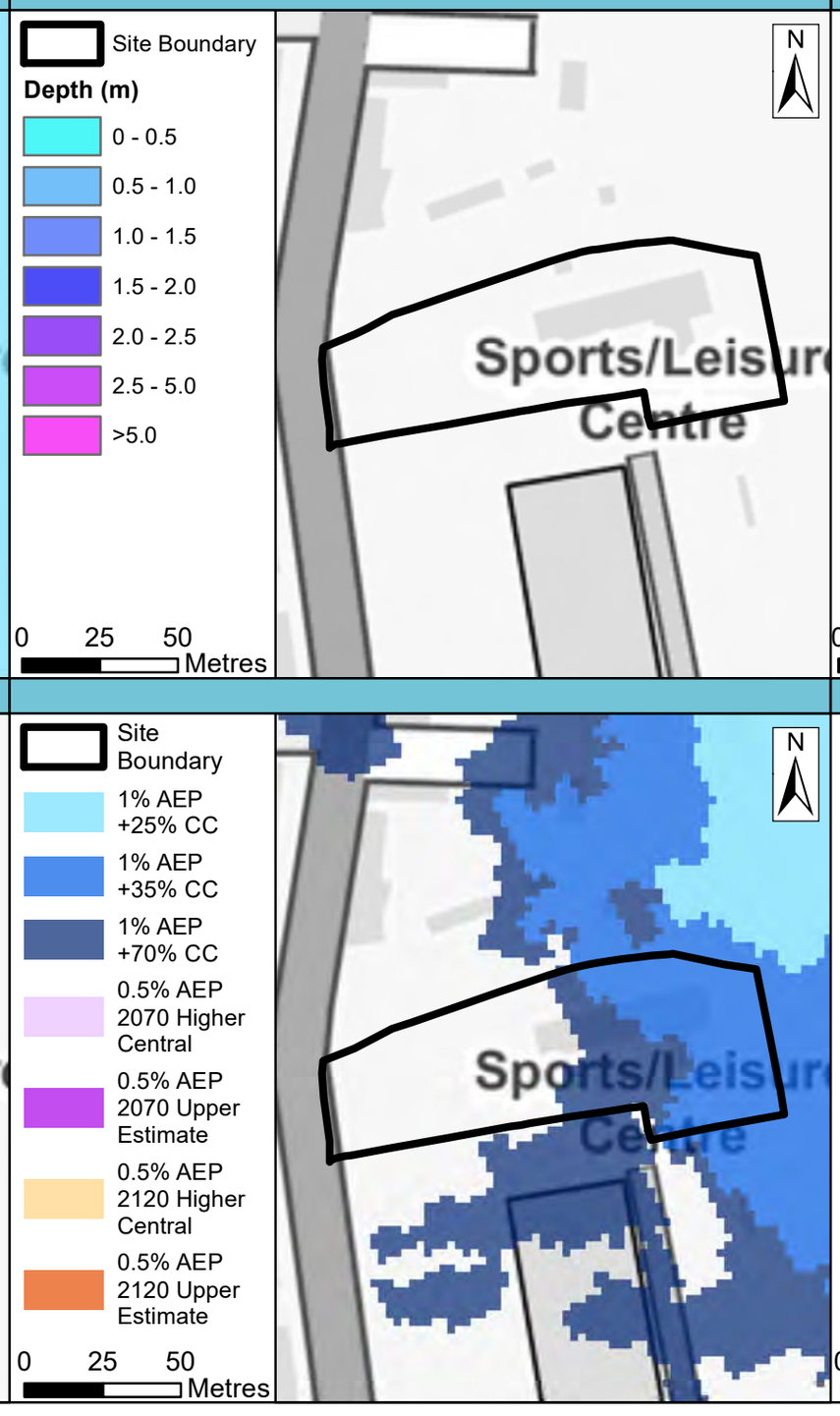

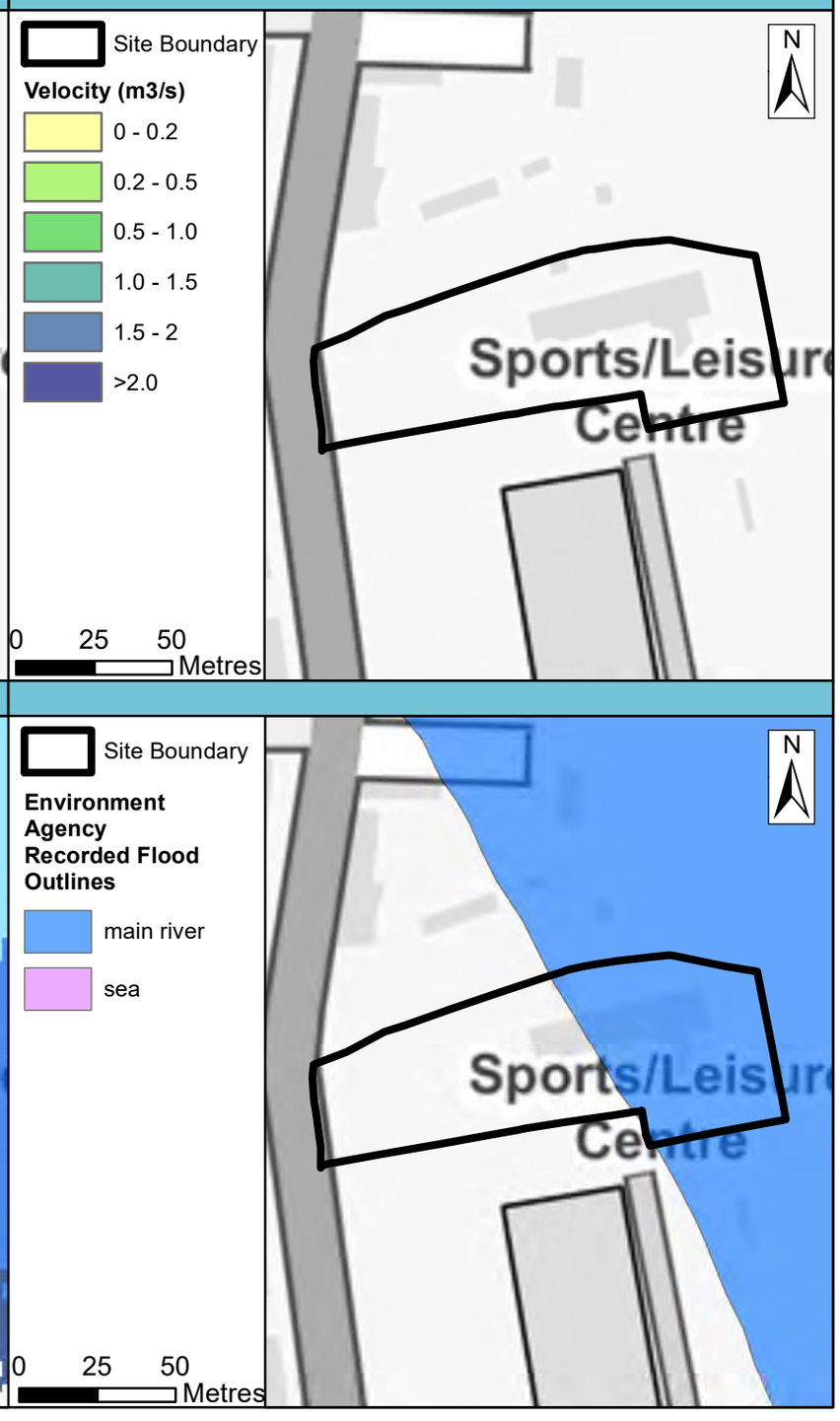

Site name	
Site area (ha)	0.67

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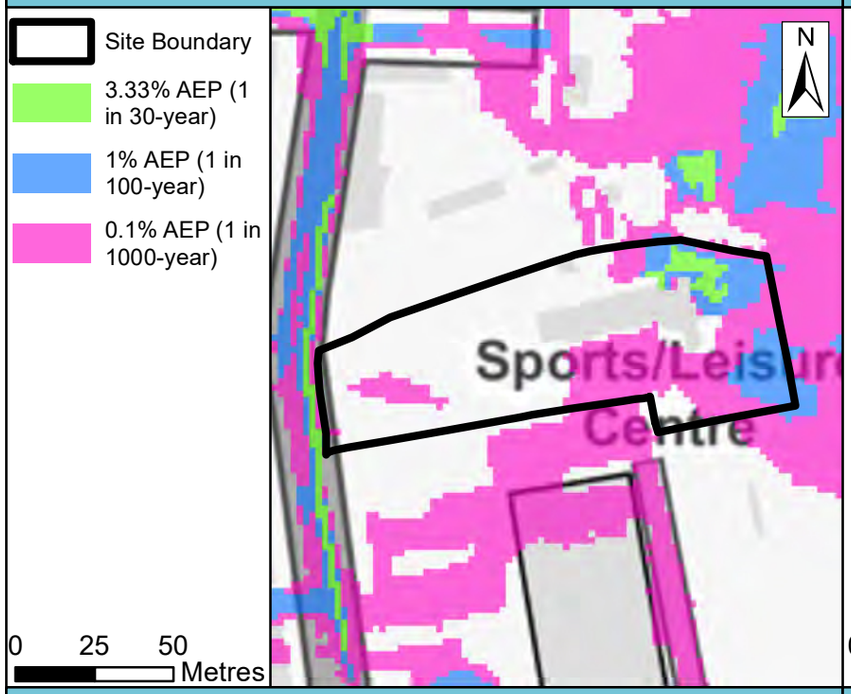

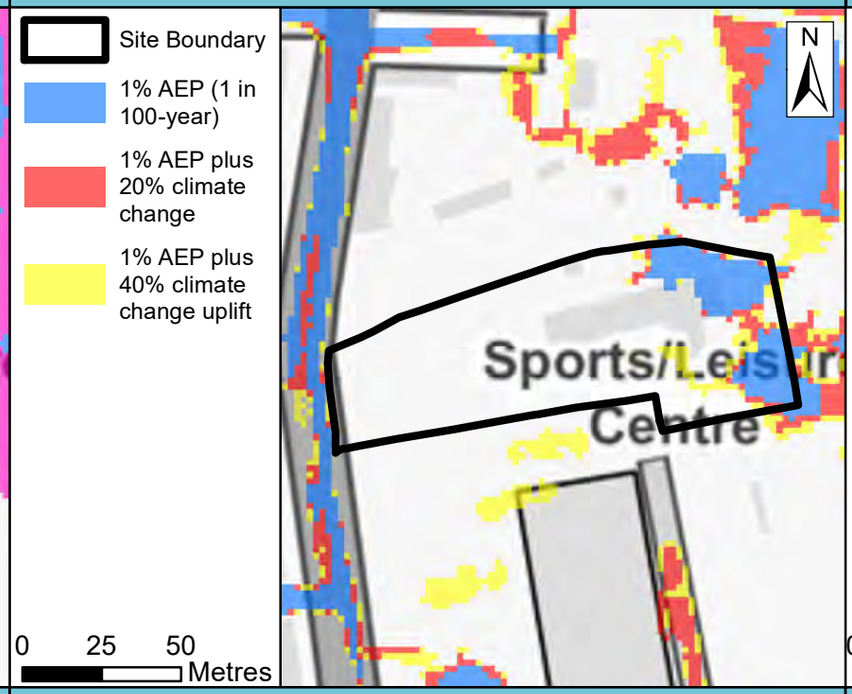

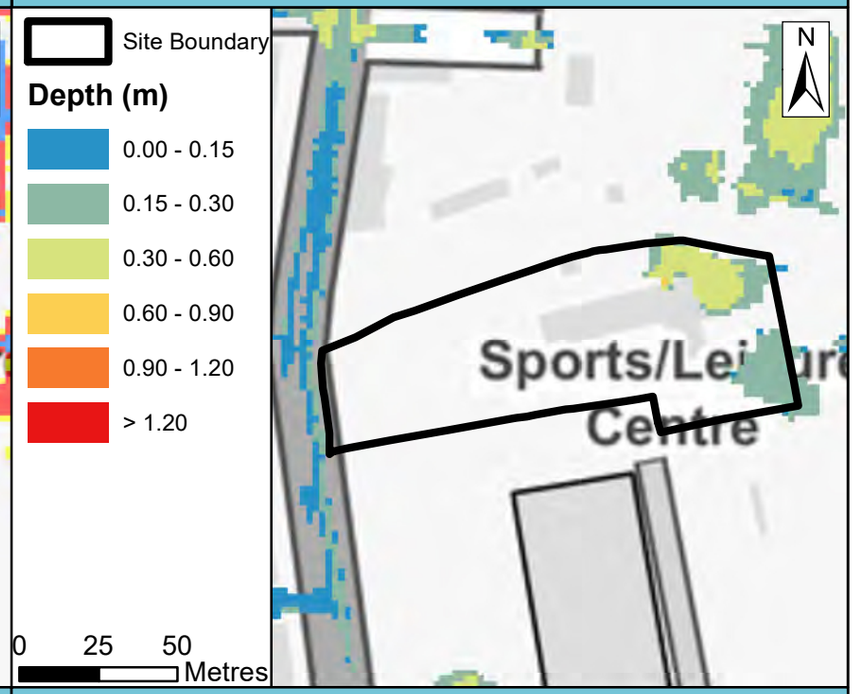

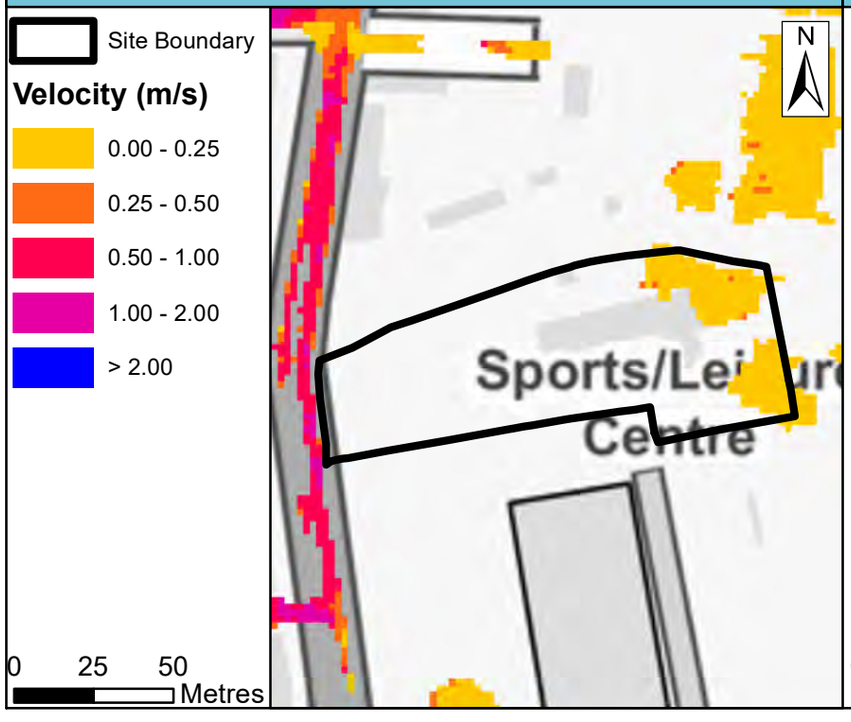

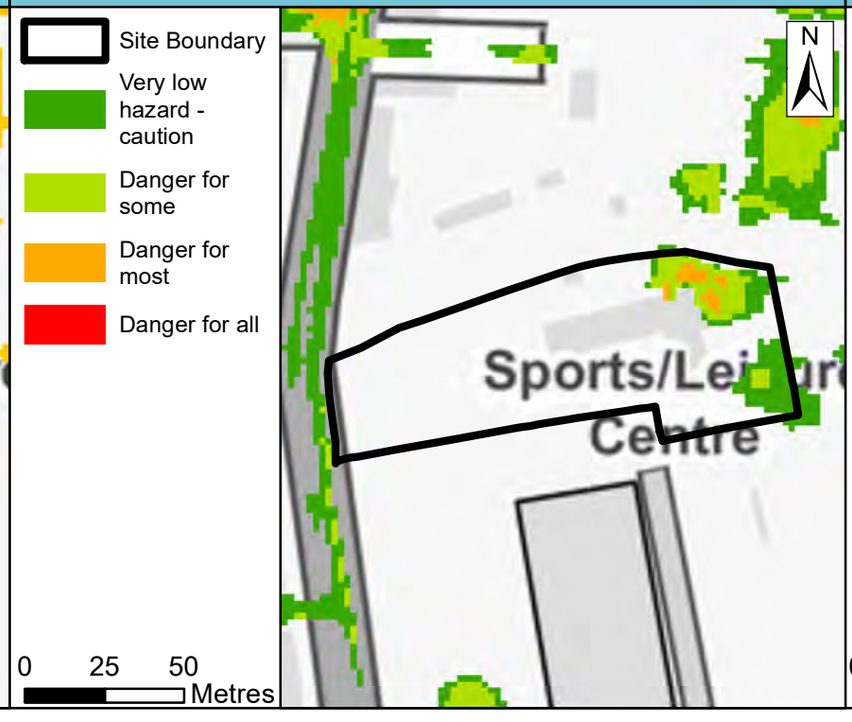

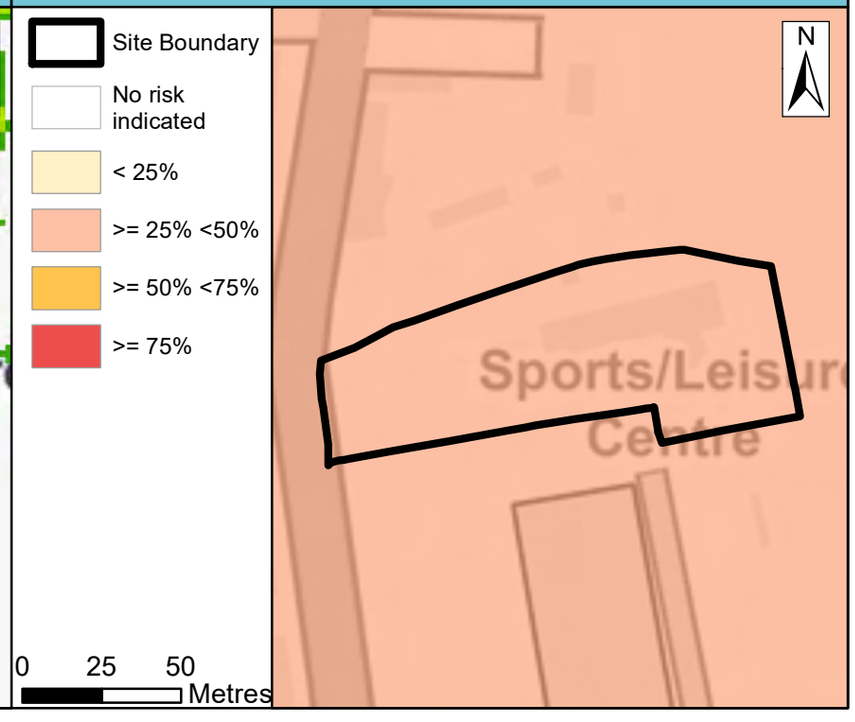

Site name	
Site area (ha)	0.67

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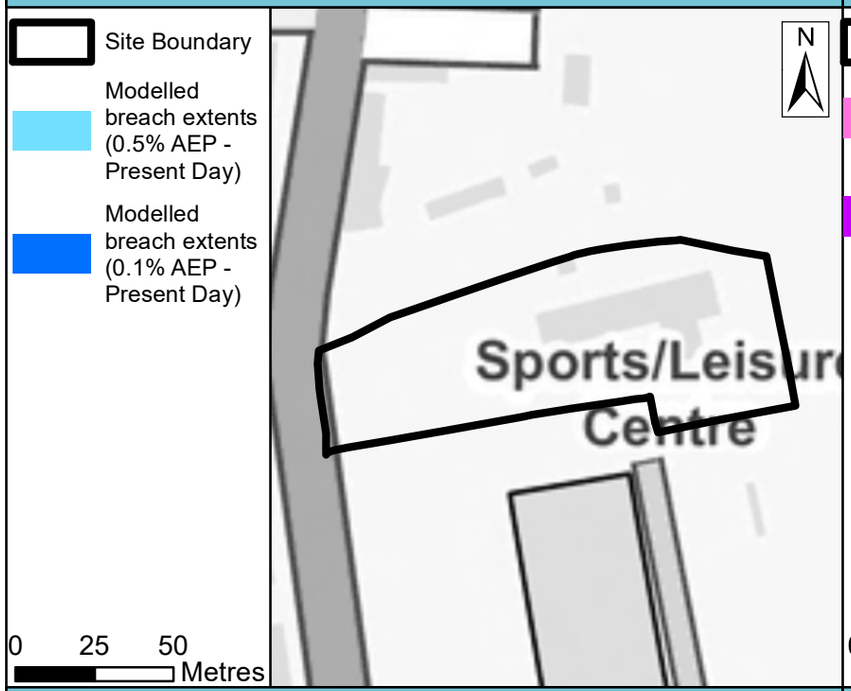

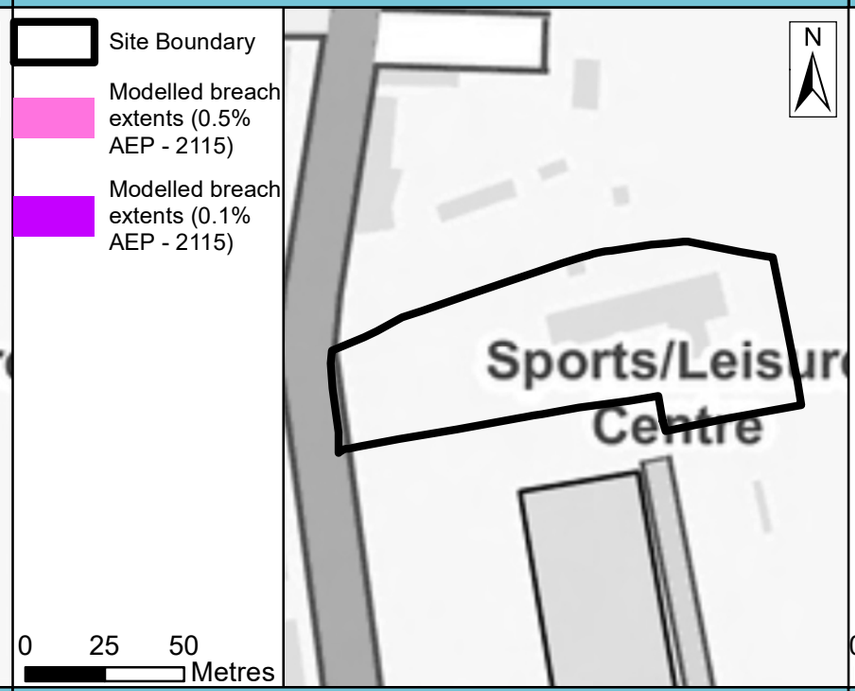

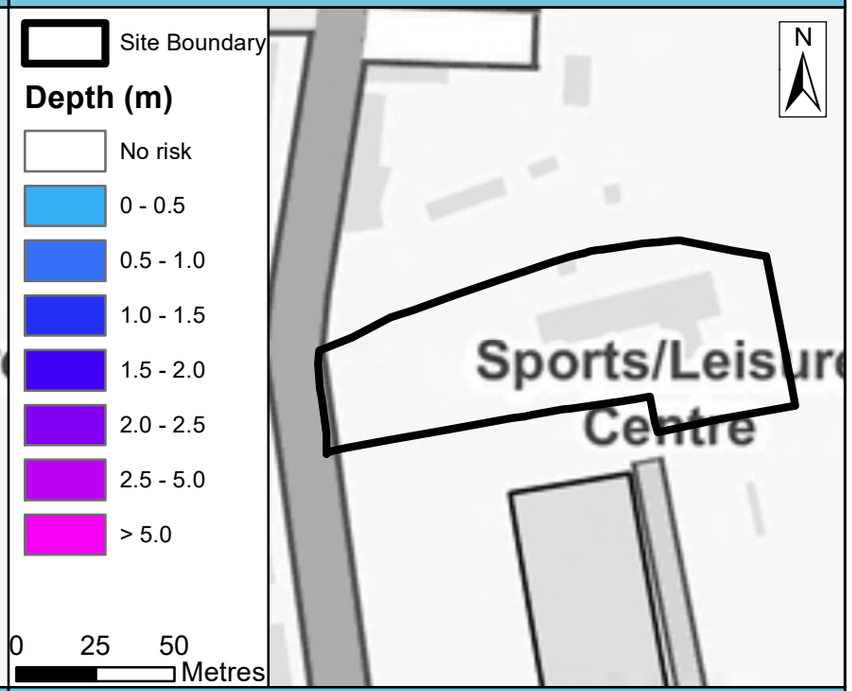

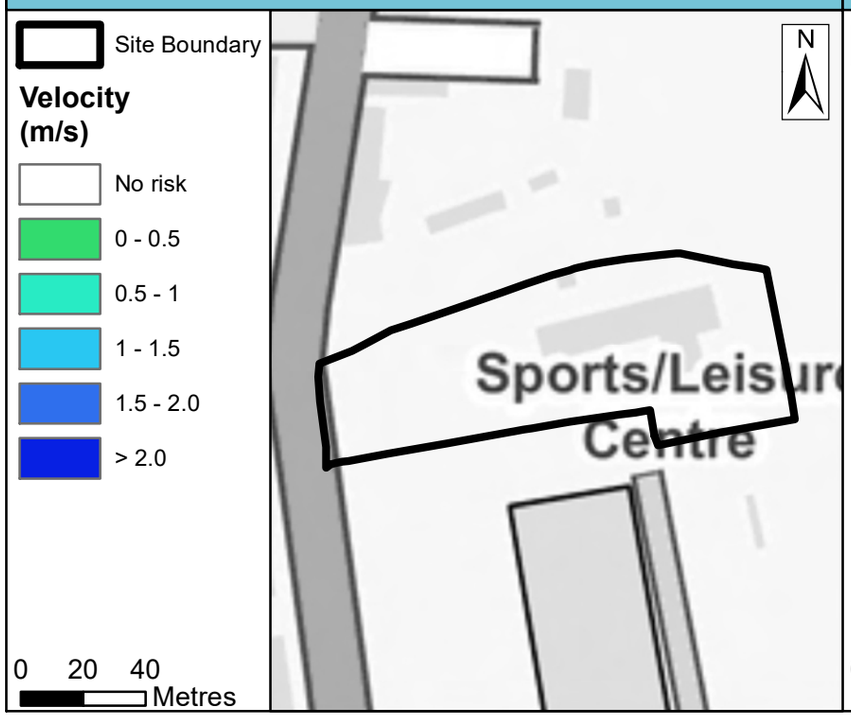

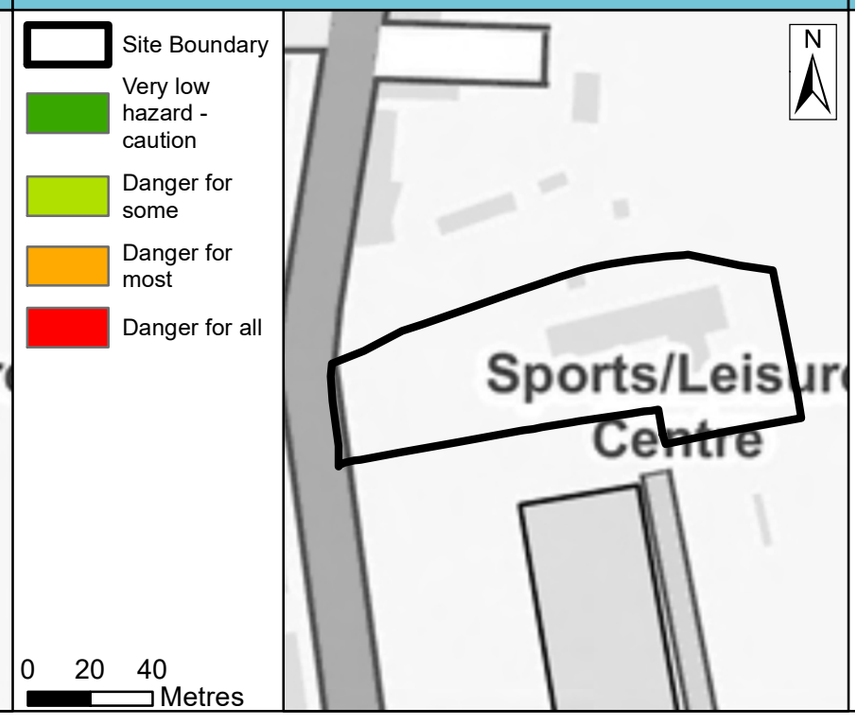

Site name	
Site area (ha)	0.87

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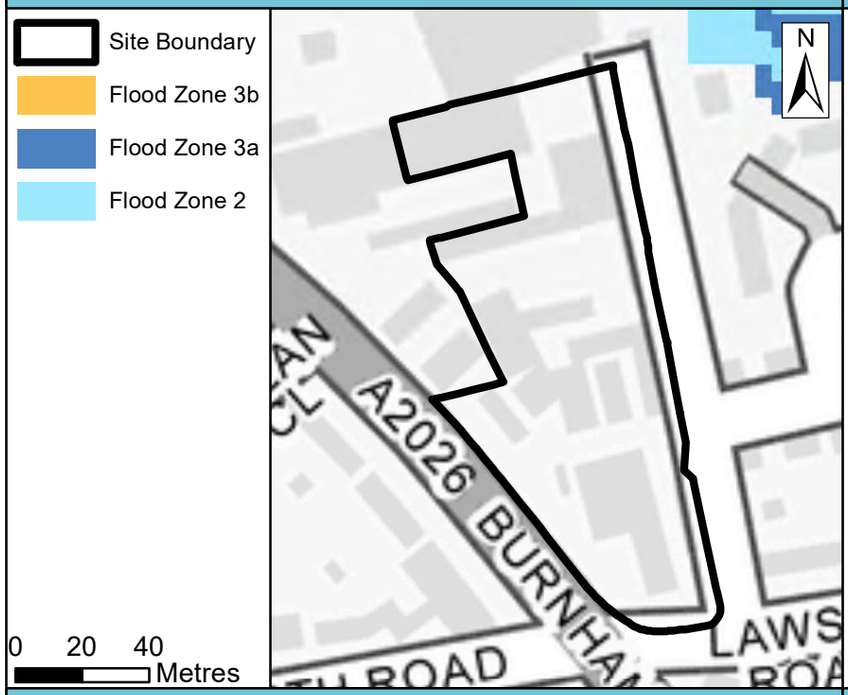

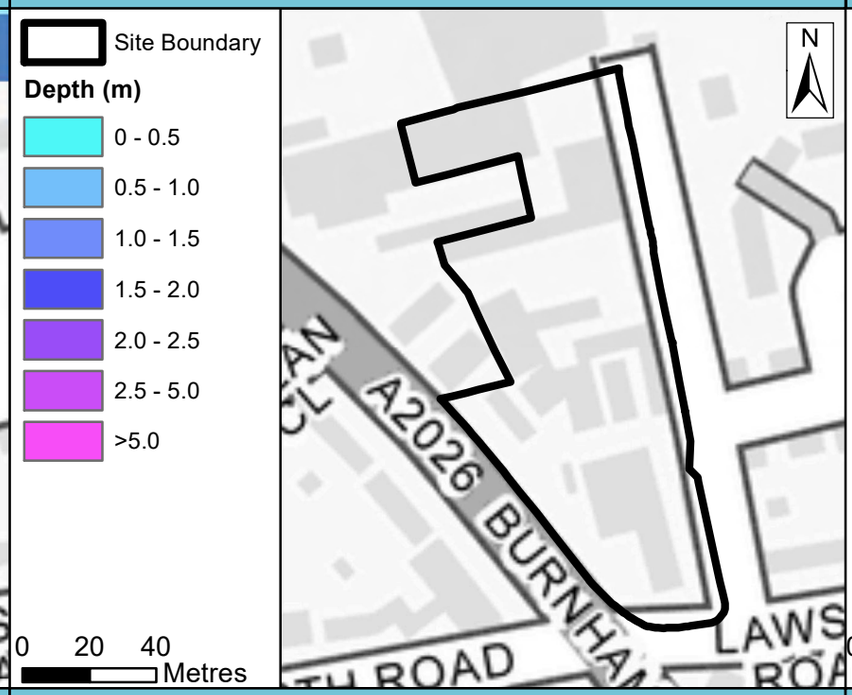

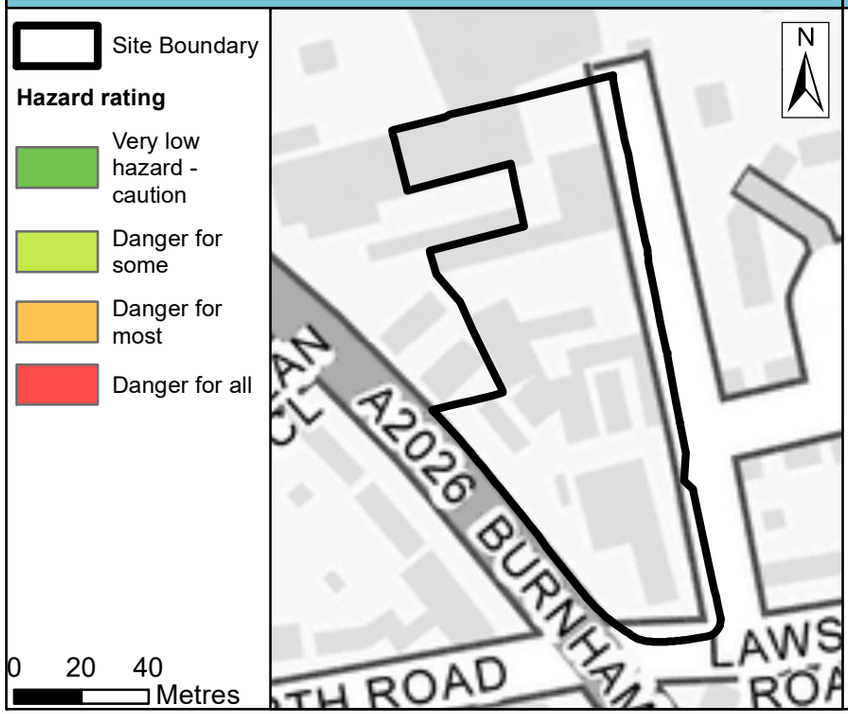

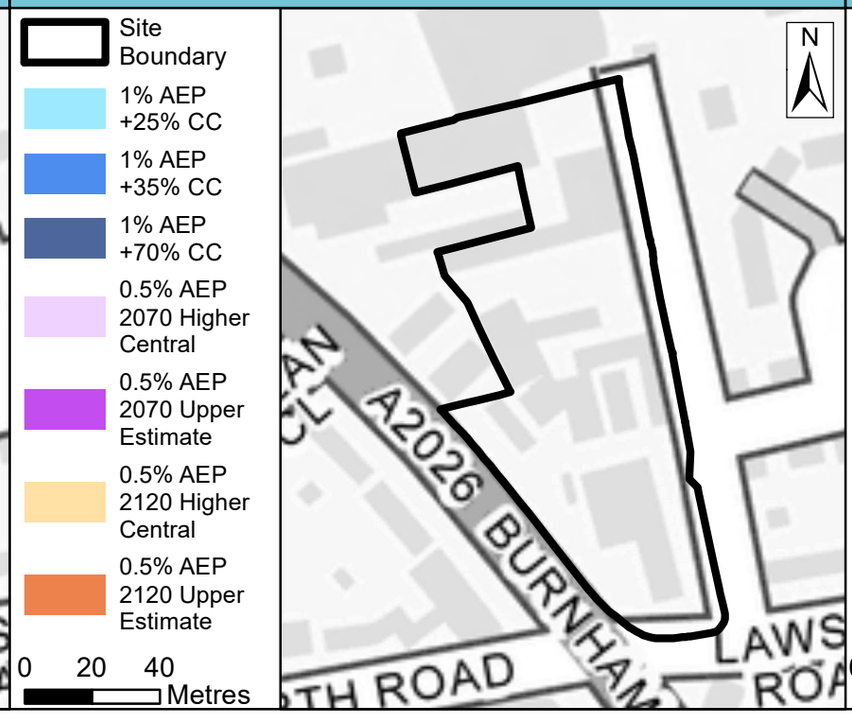

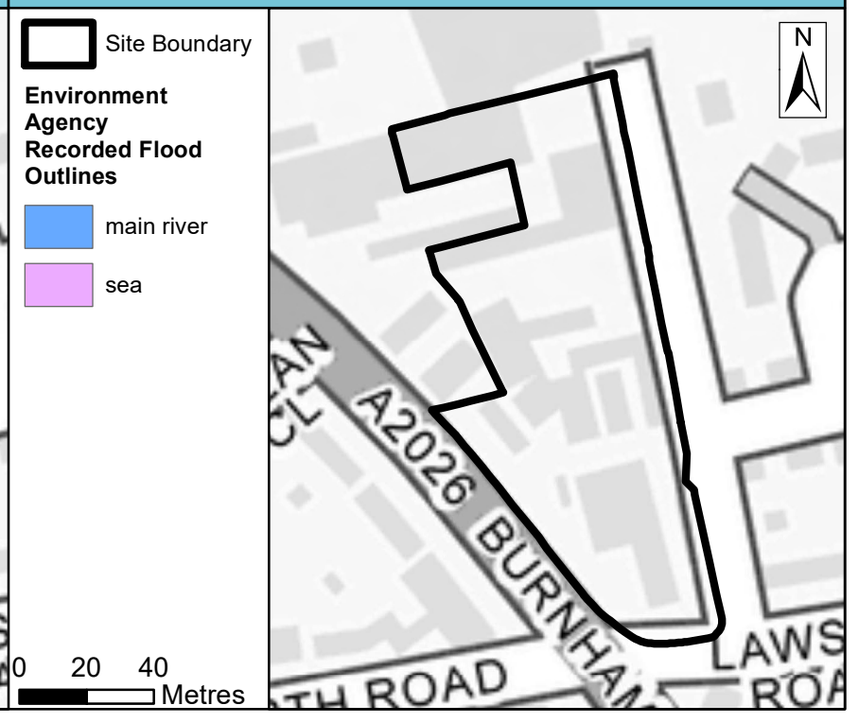

Site name	
Site area (ha)	0.87

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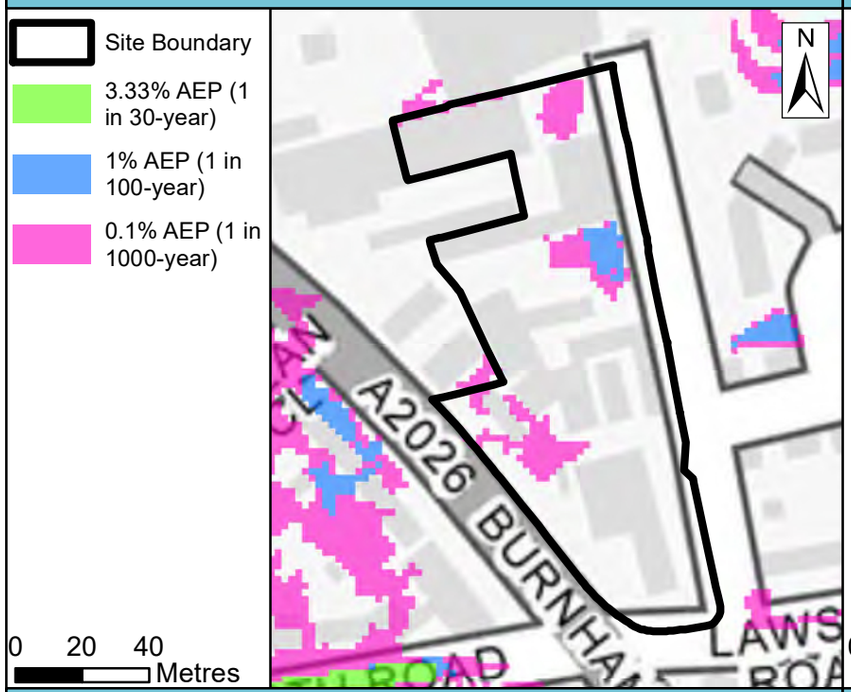

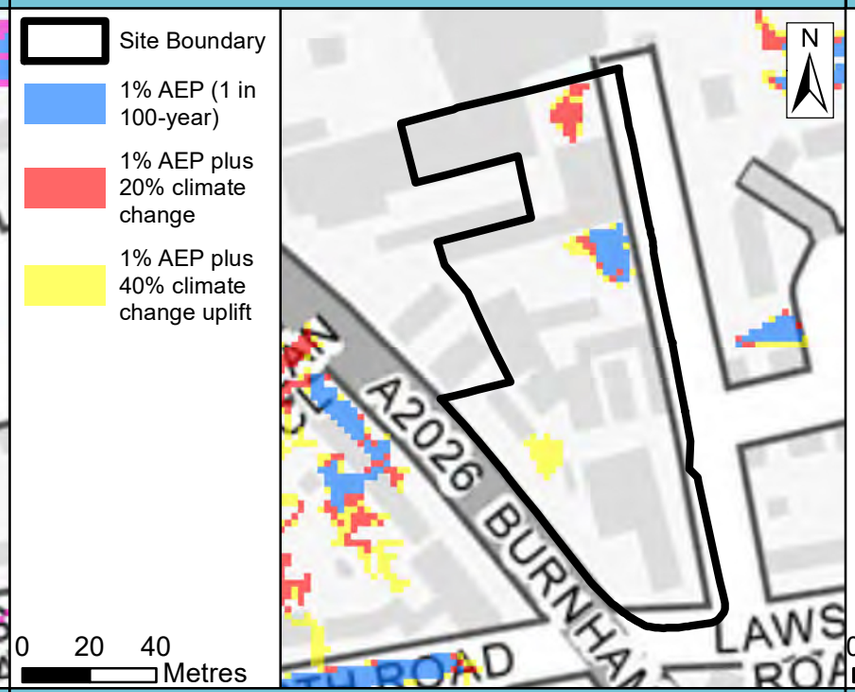

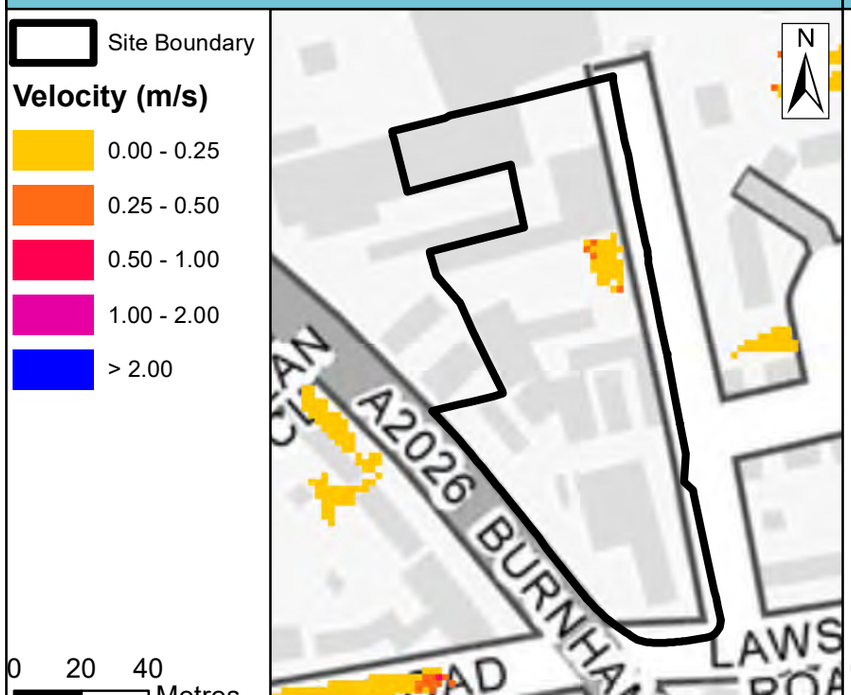

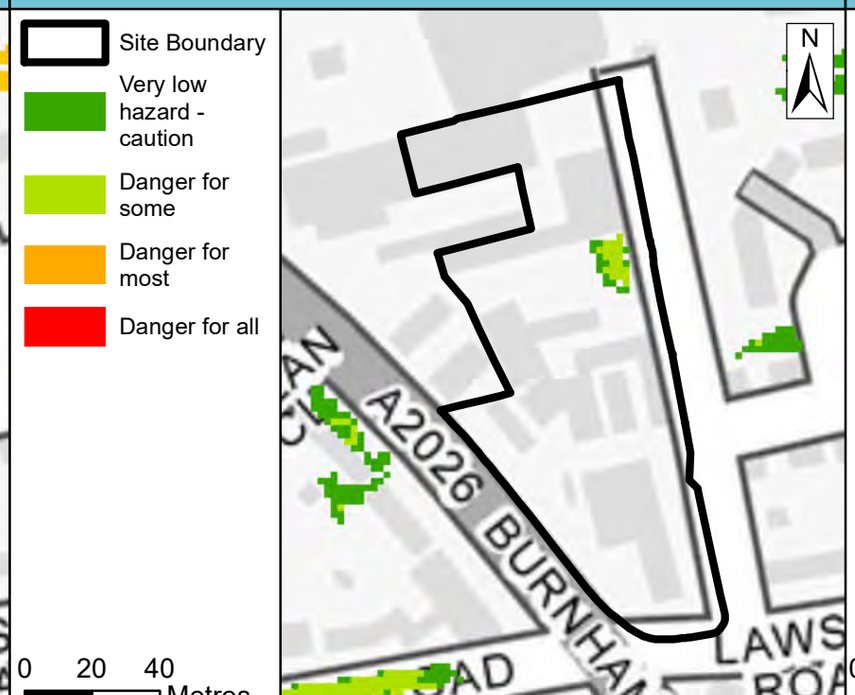

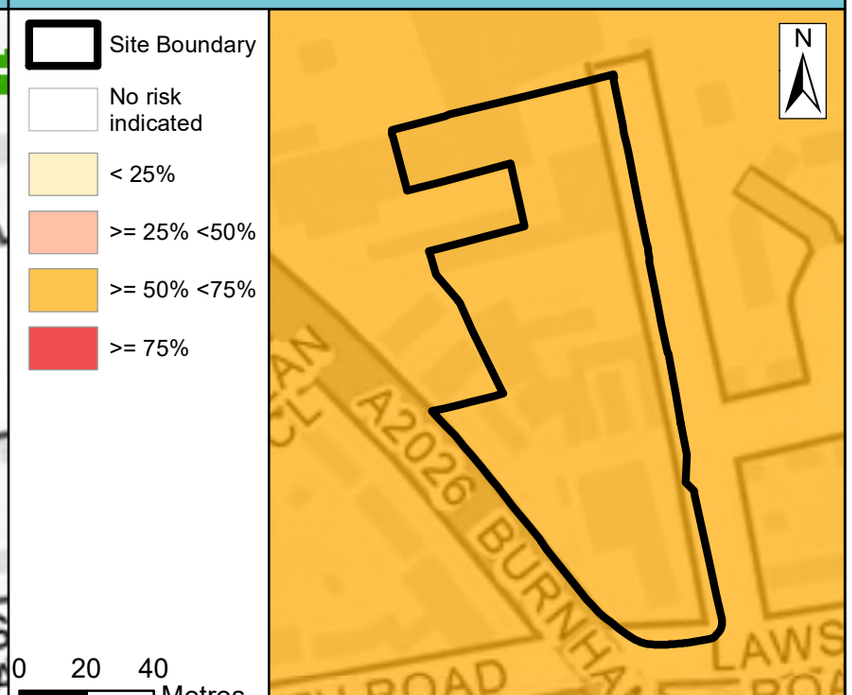

Site name	
Site area (ha)	0.87

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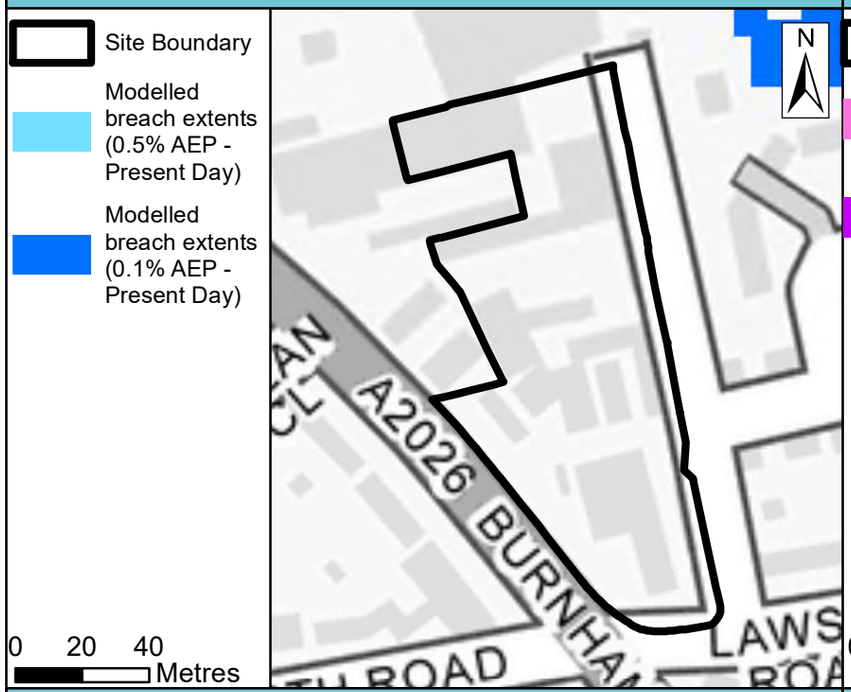

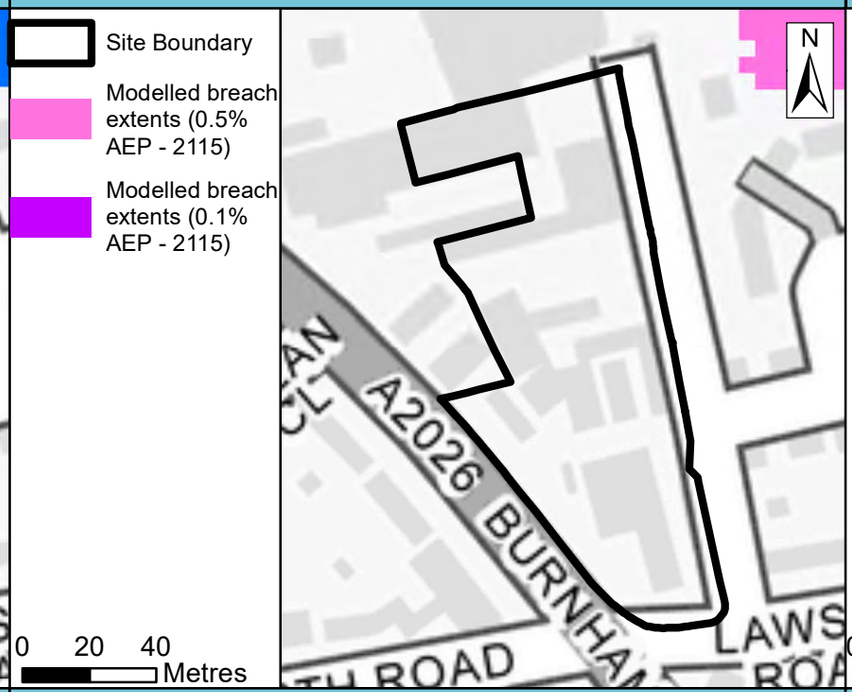

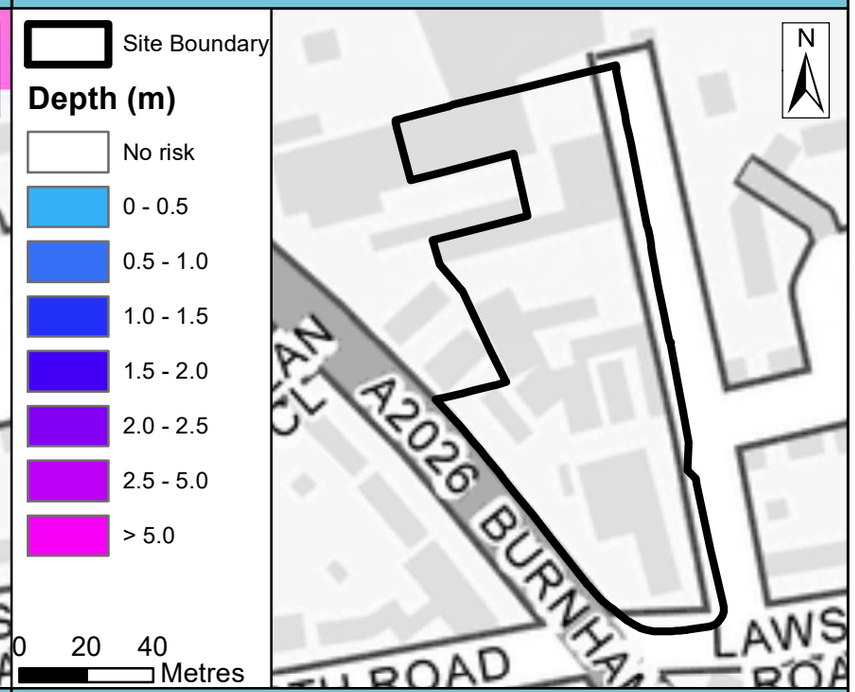

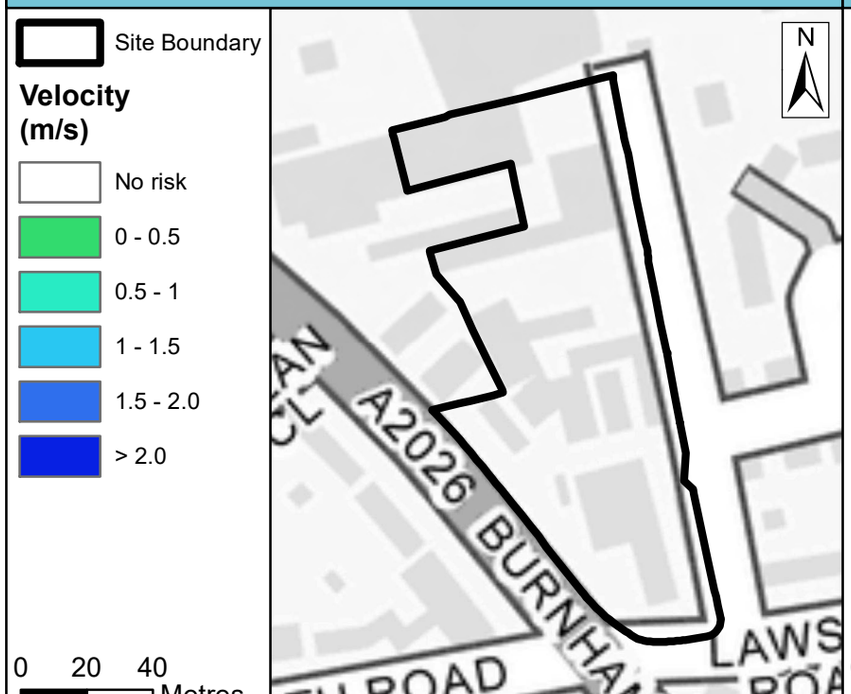

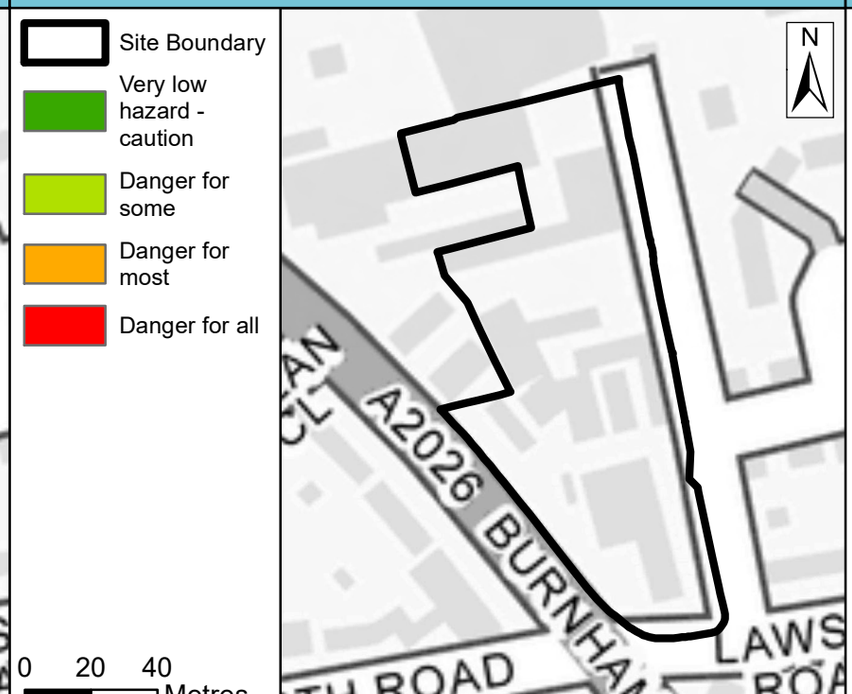

Site name	
Site area (ha)	5.03

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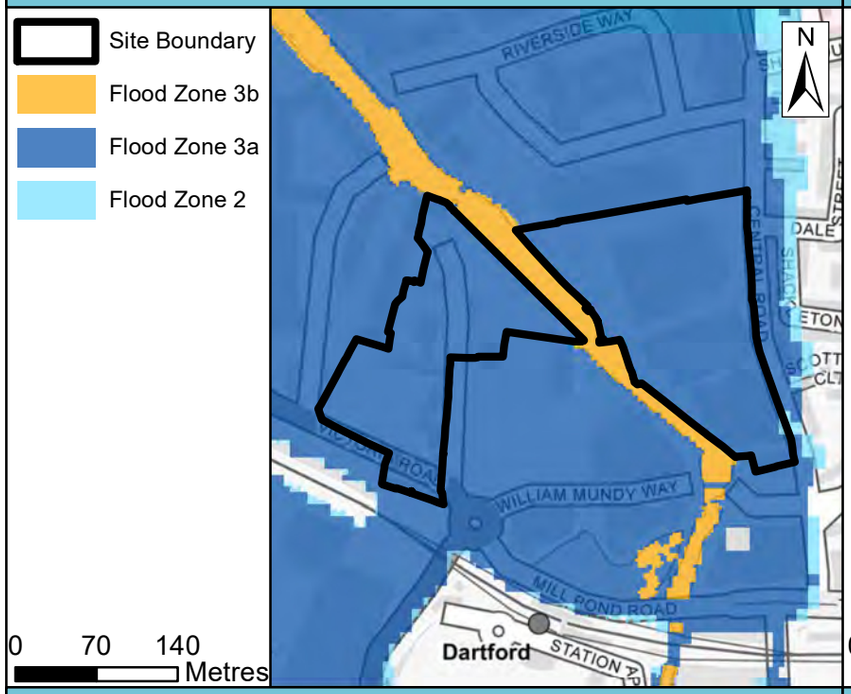

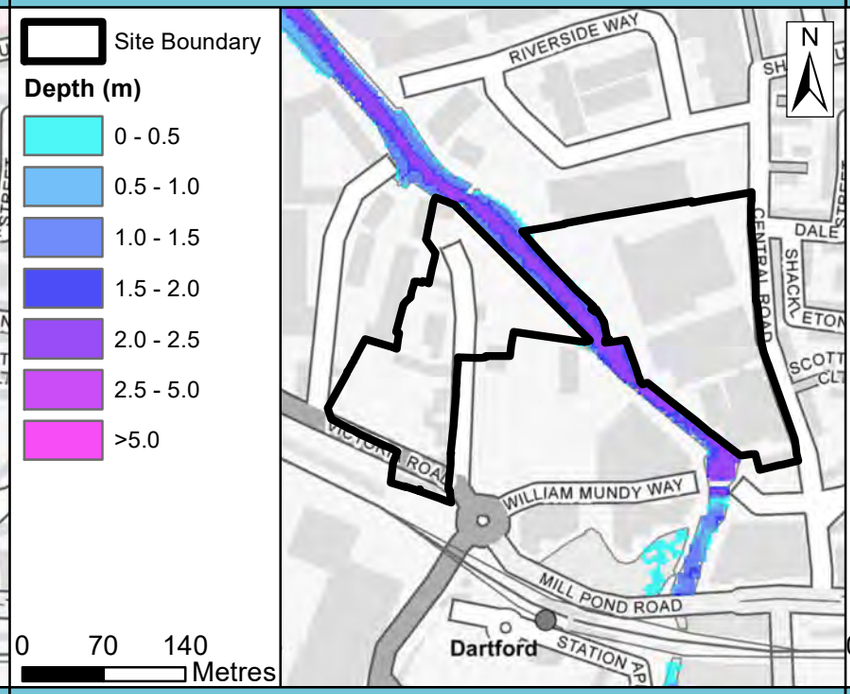

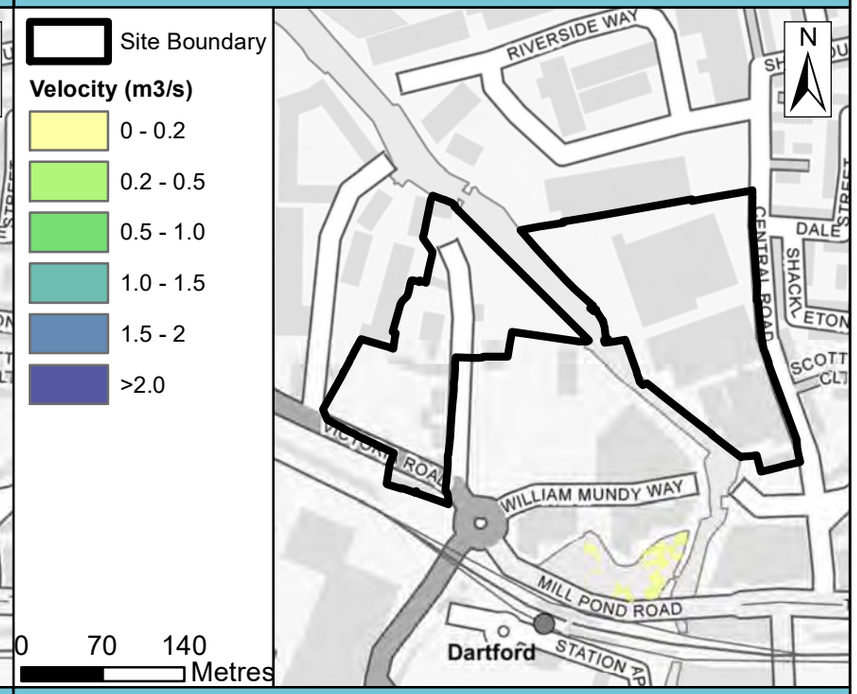

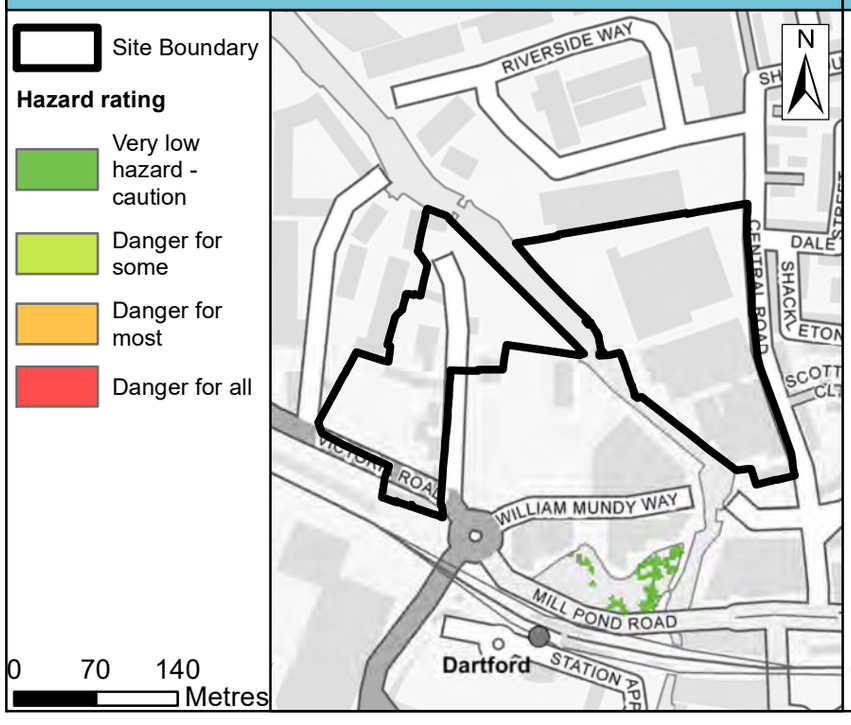

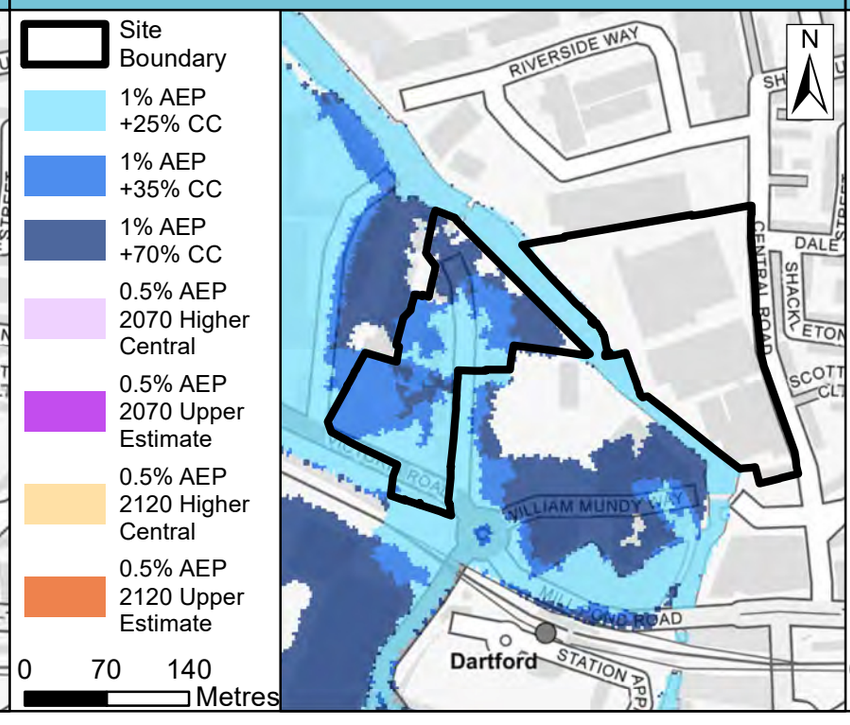

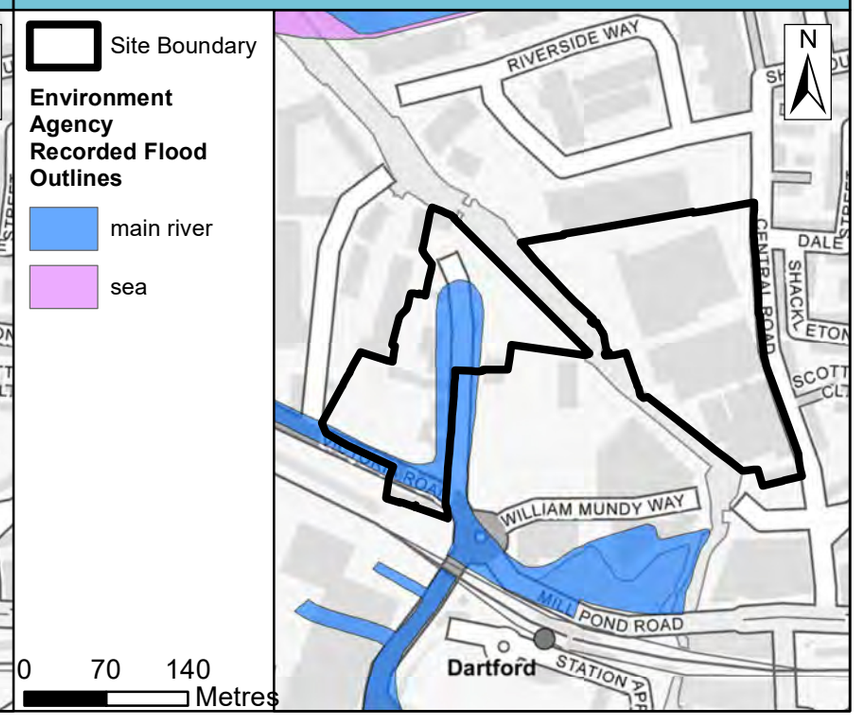

Site name	
Site area (ha)	5.03

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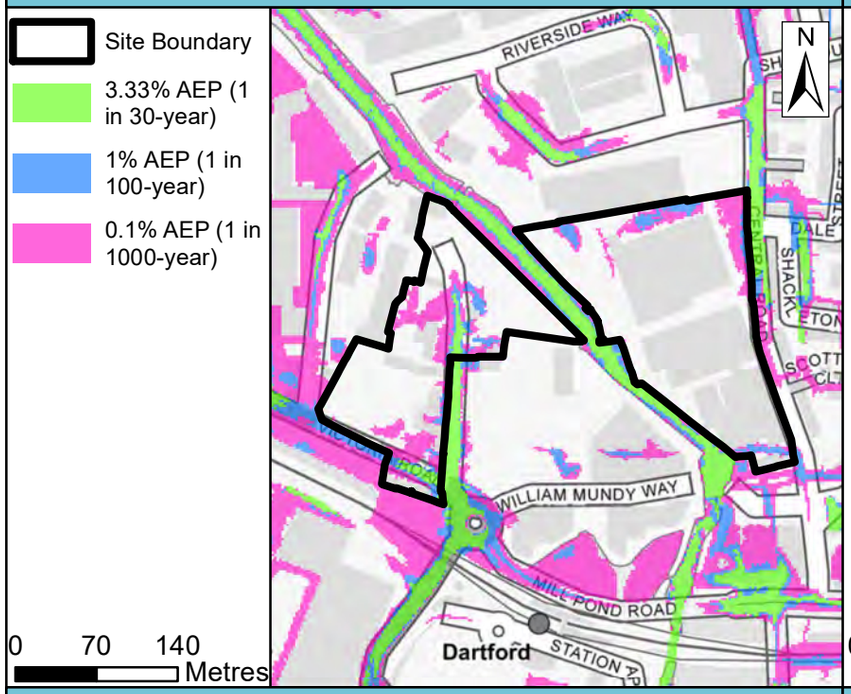

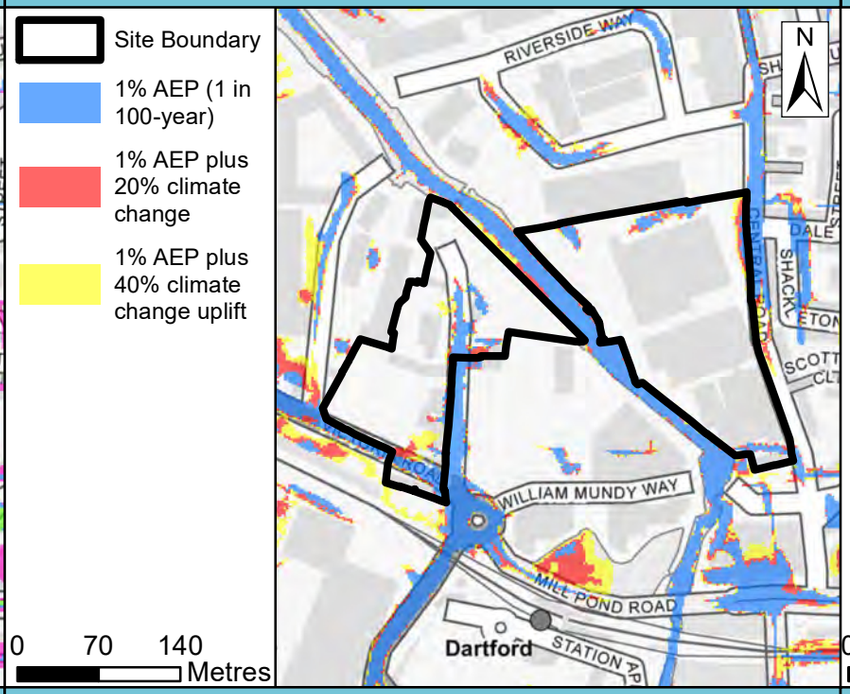

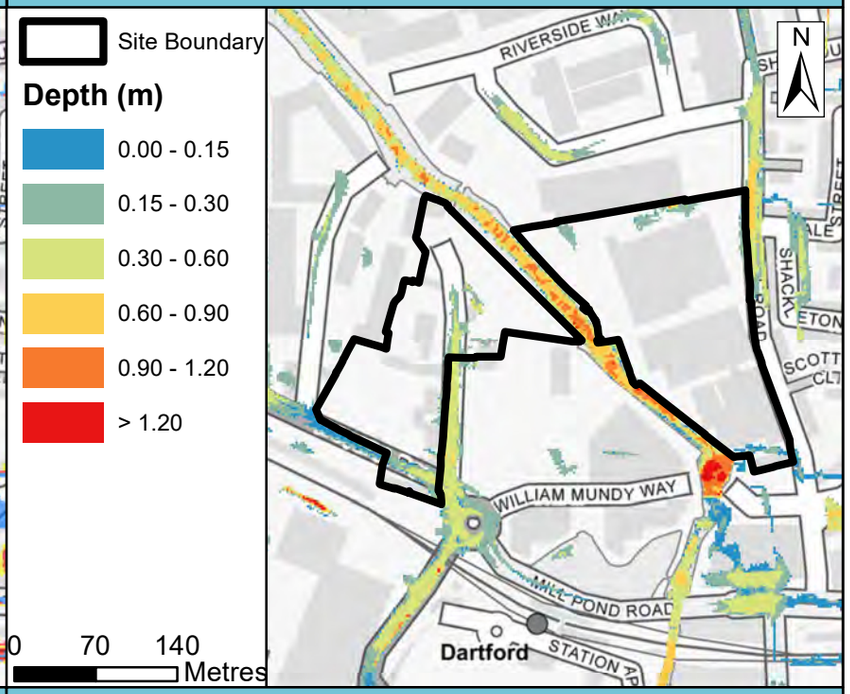

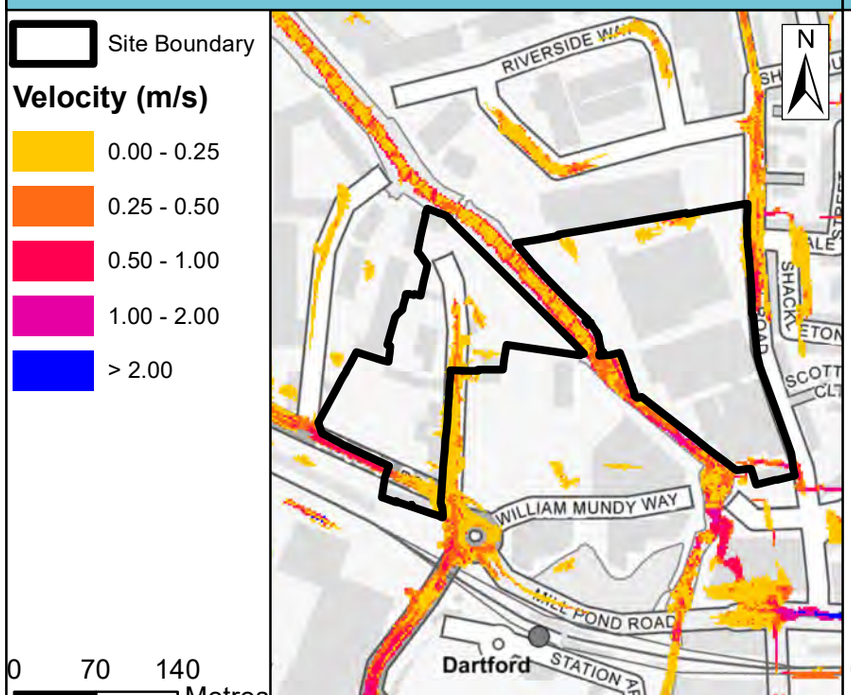

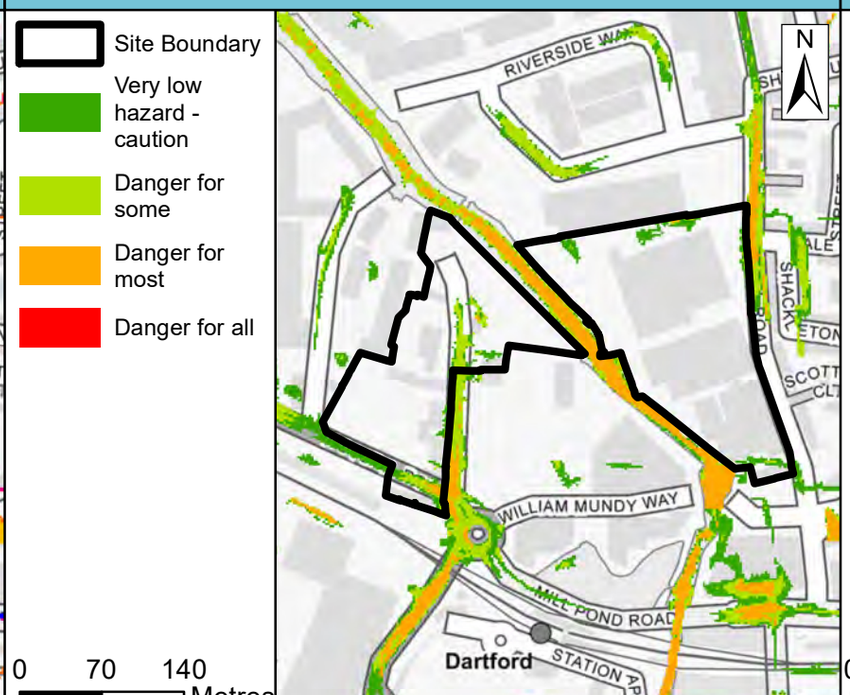

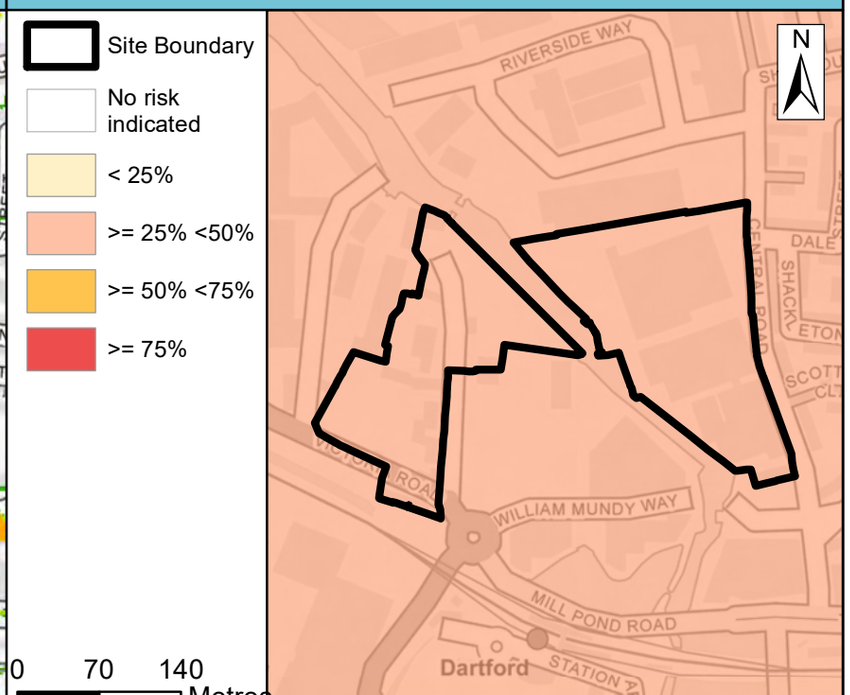

Site name	
Site area (ha)	5.03

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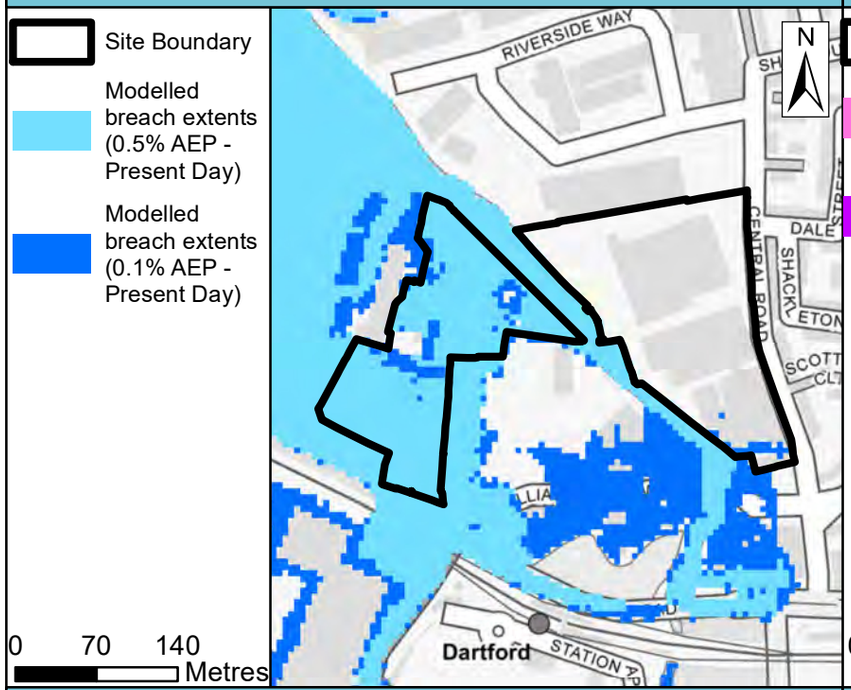

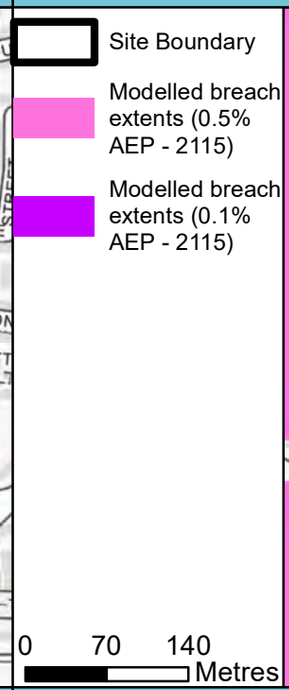

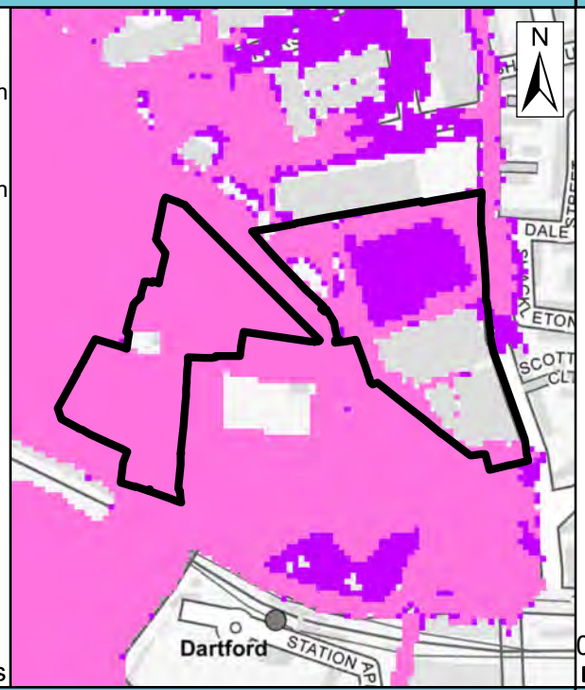

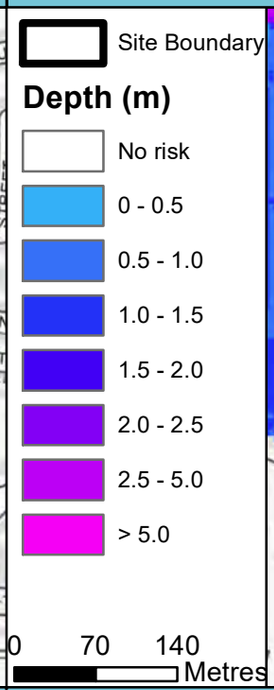

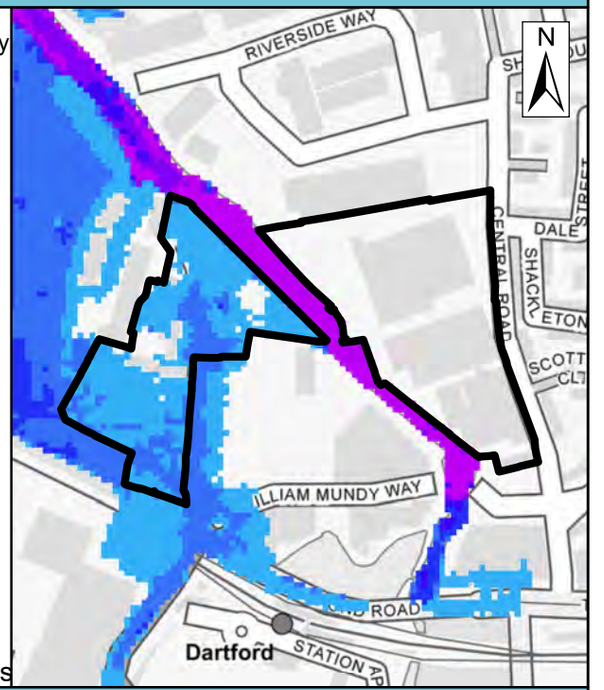

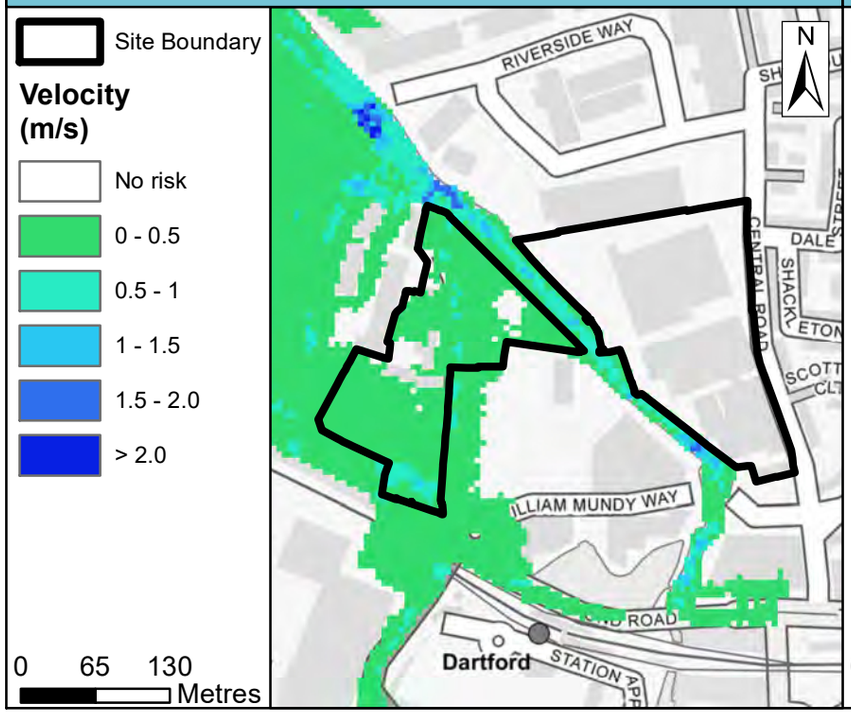

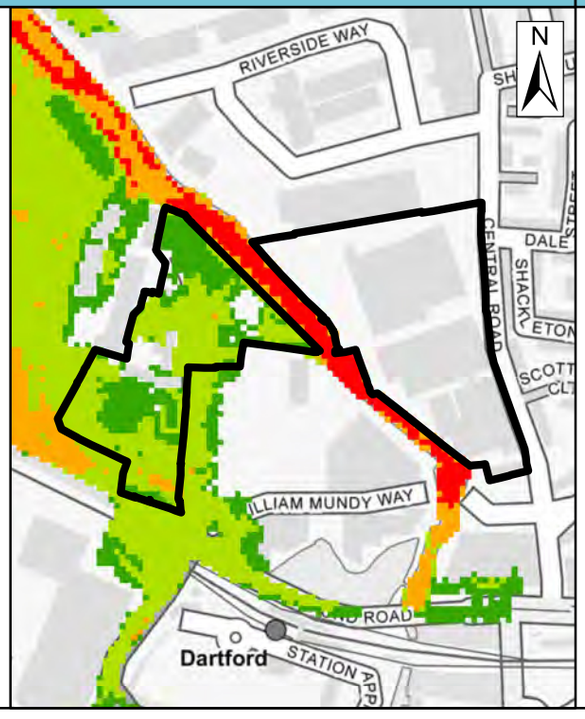

Site name	
Site area (ha)	125.13

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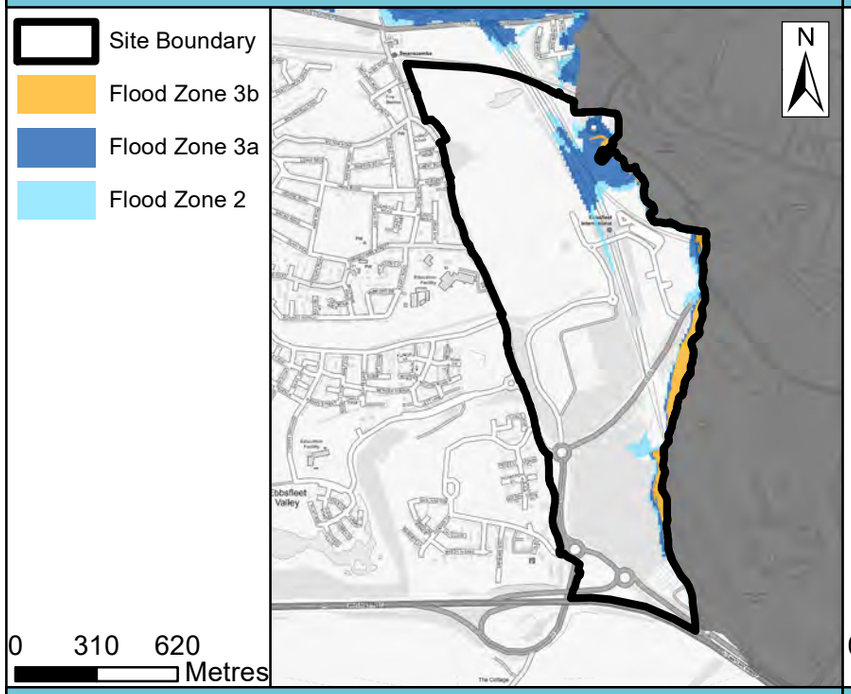

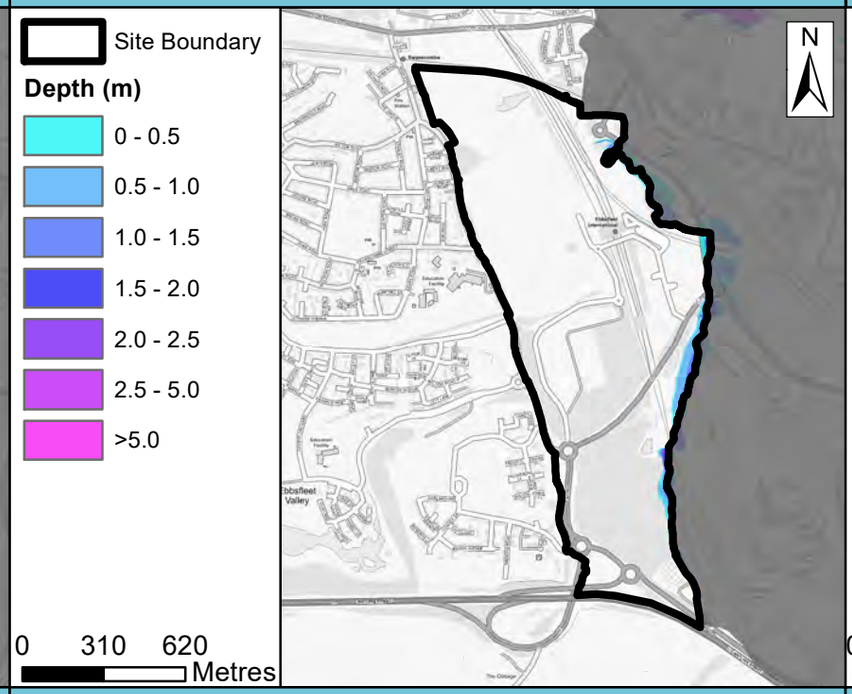

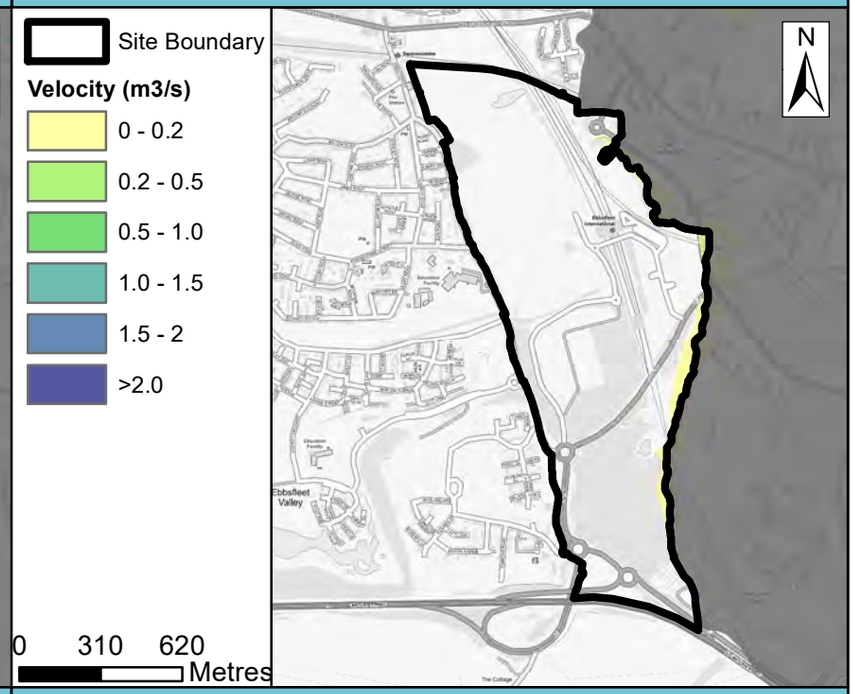

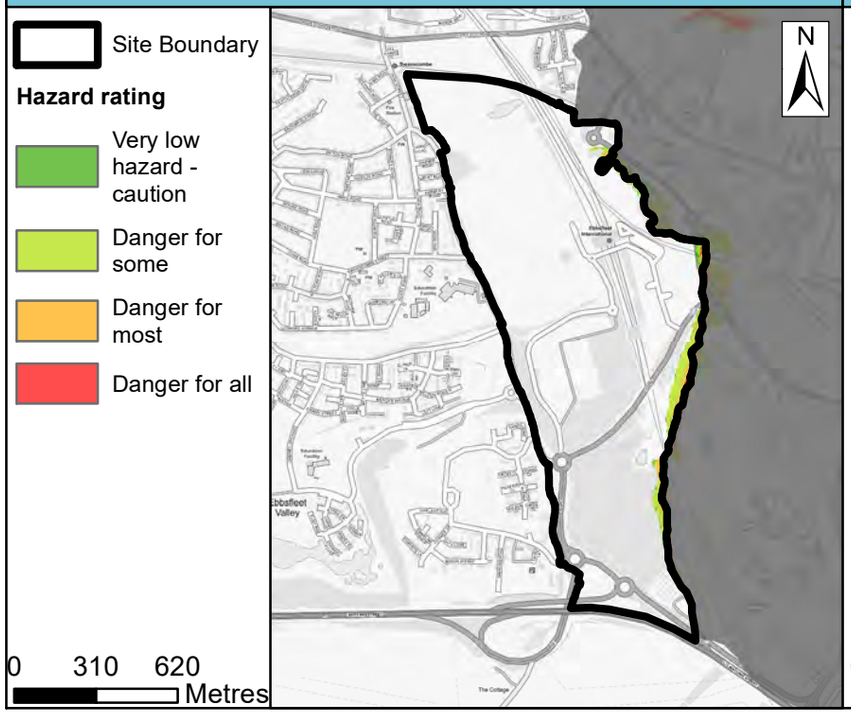

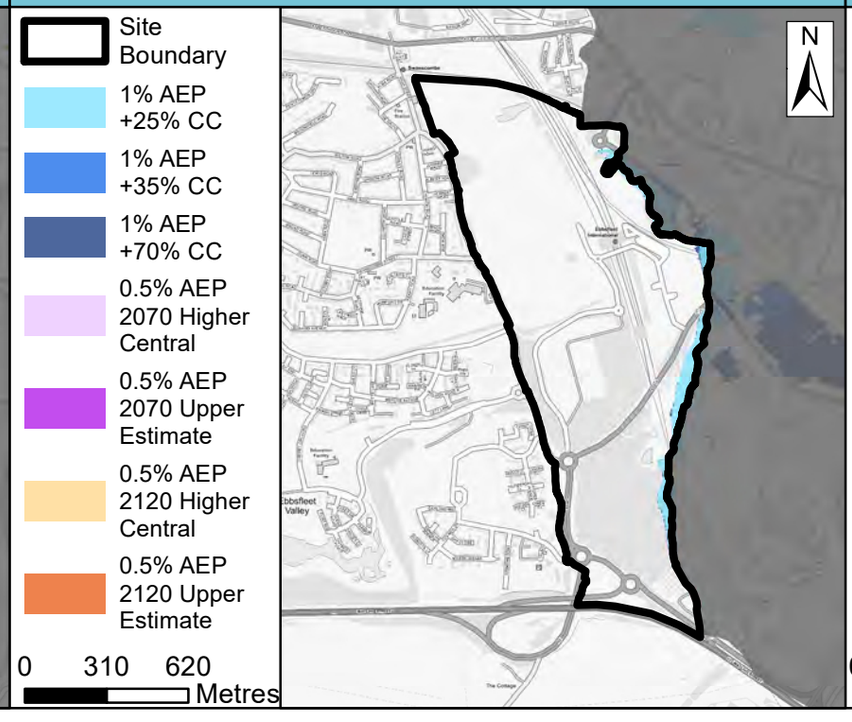

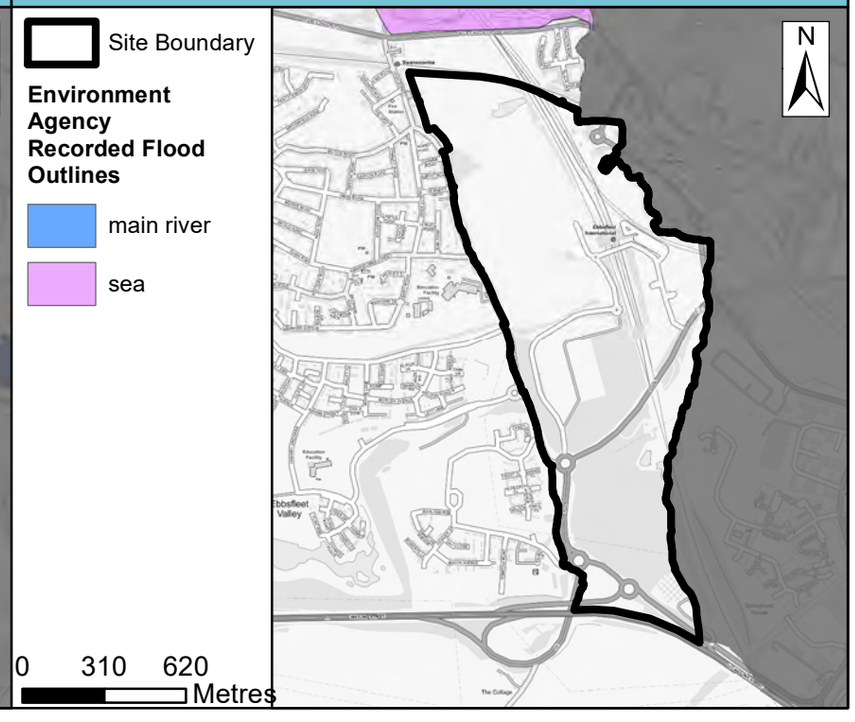

Site name	
Site area (ha)	125.13

DARTFORD BOROUGH COUNCIL

JBA consulting

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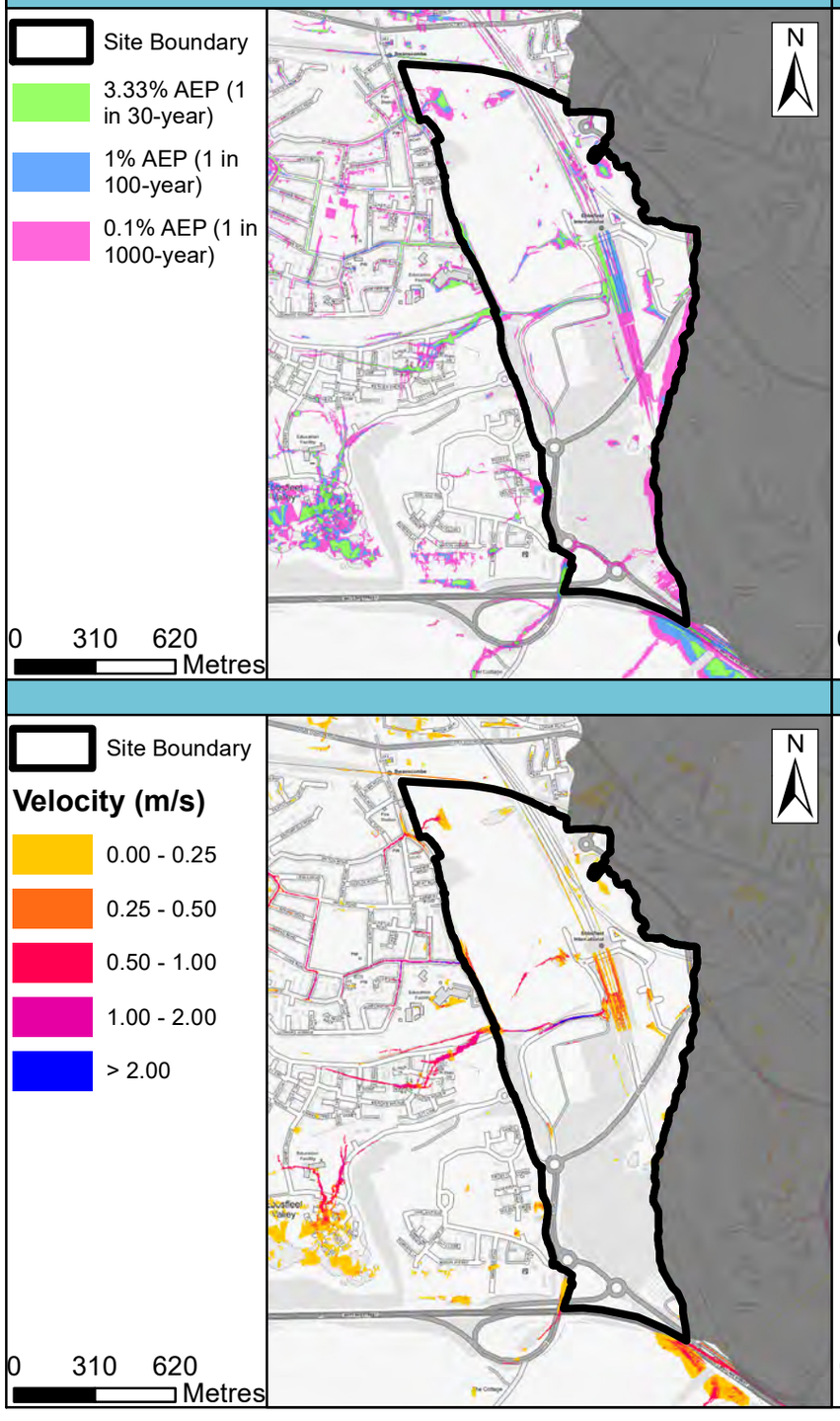

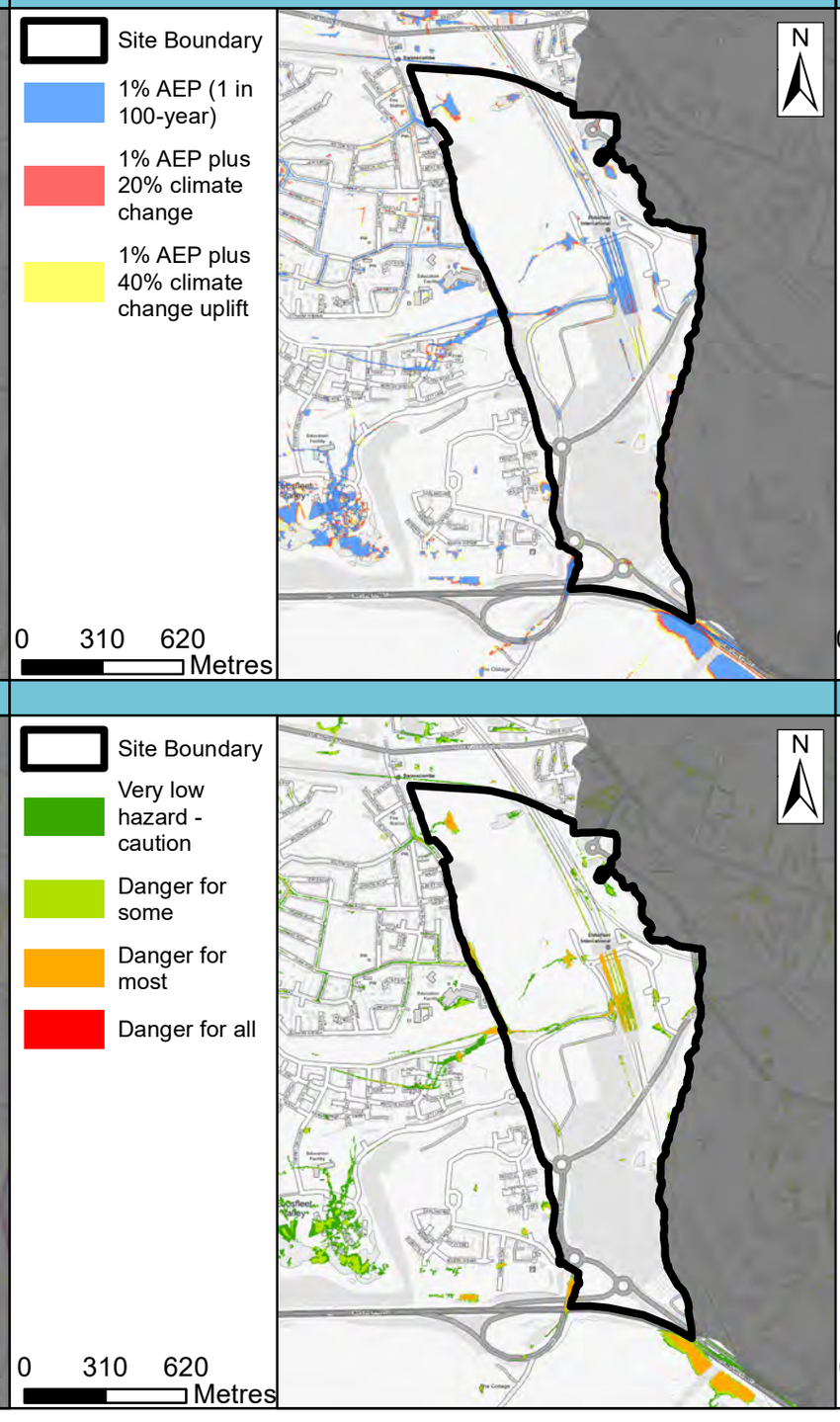

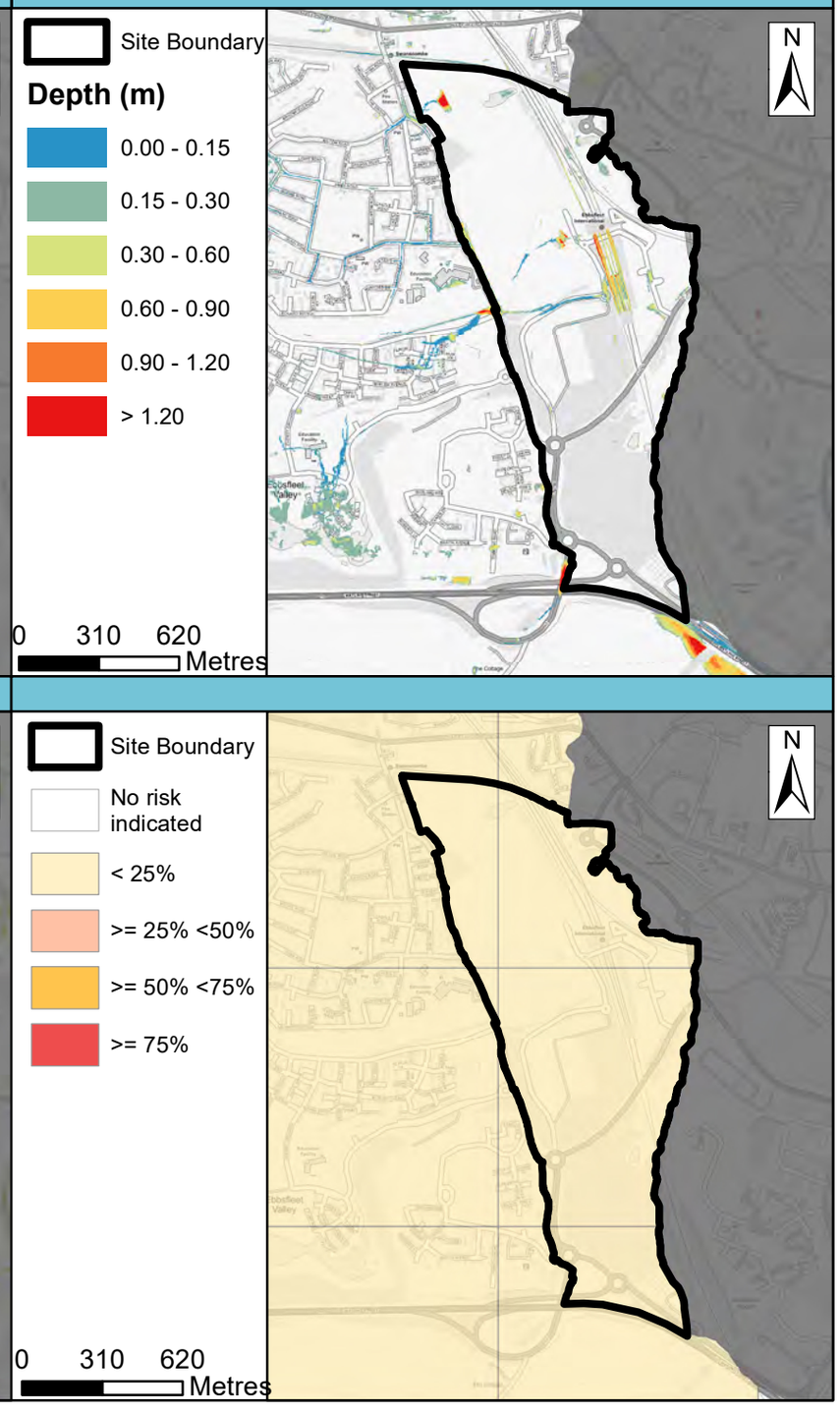

Site name	
Site area (ha)	125.13

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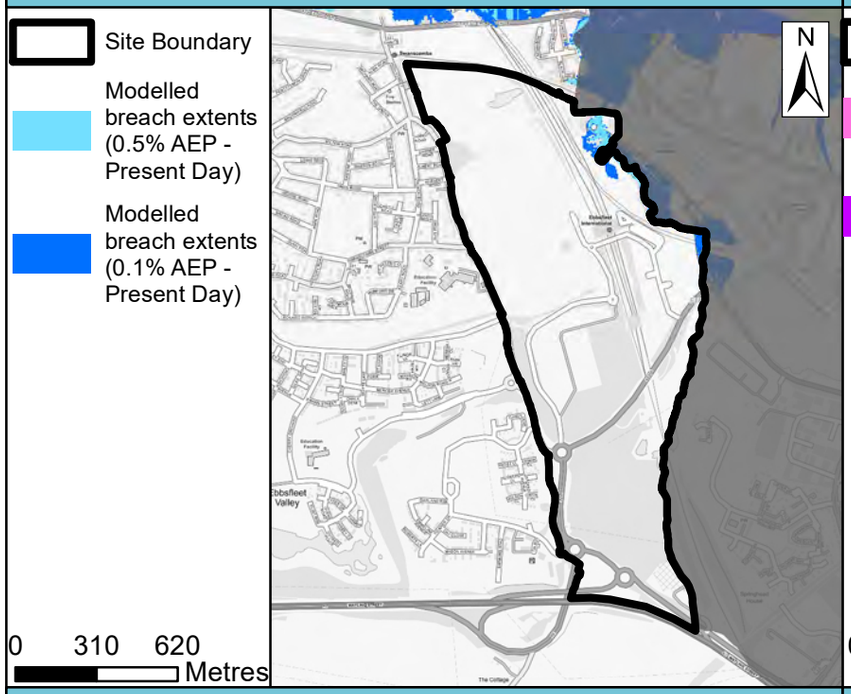

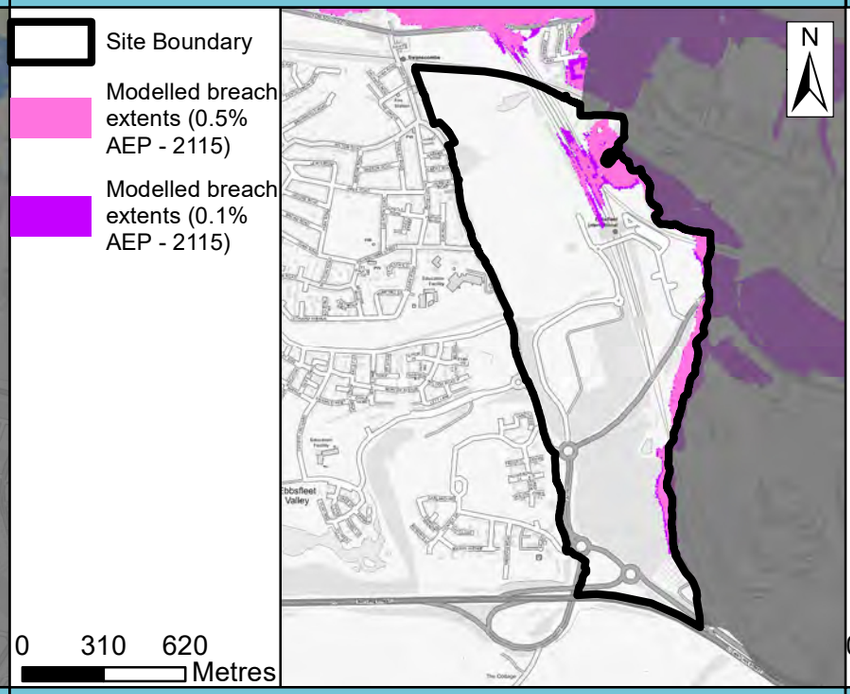

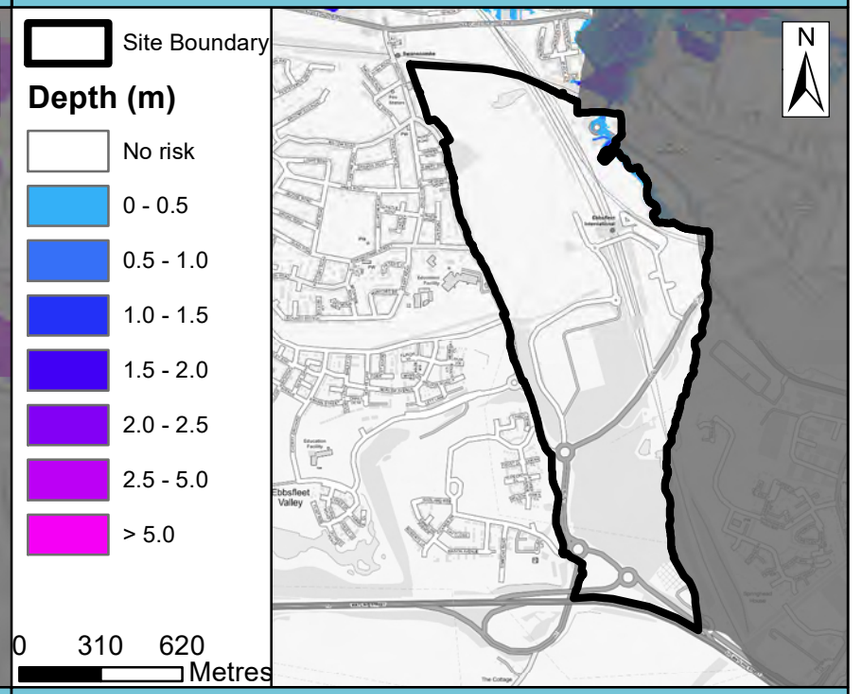

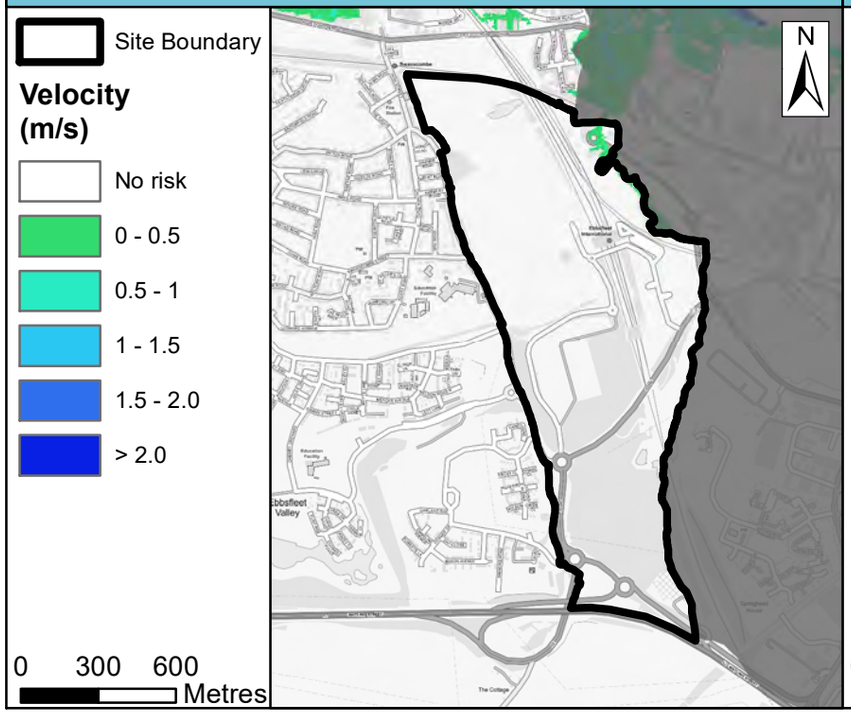

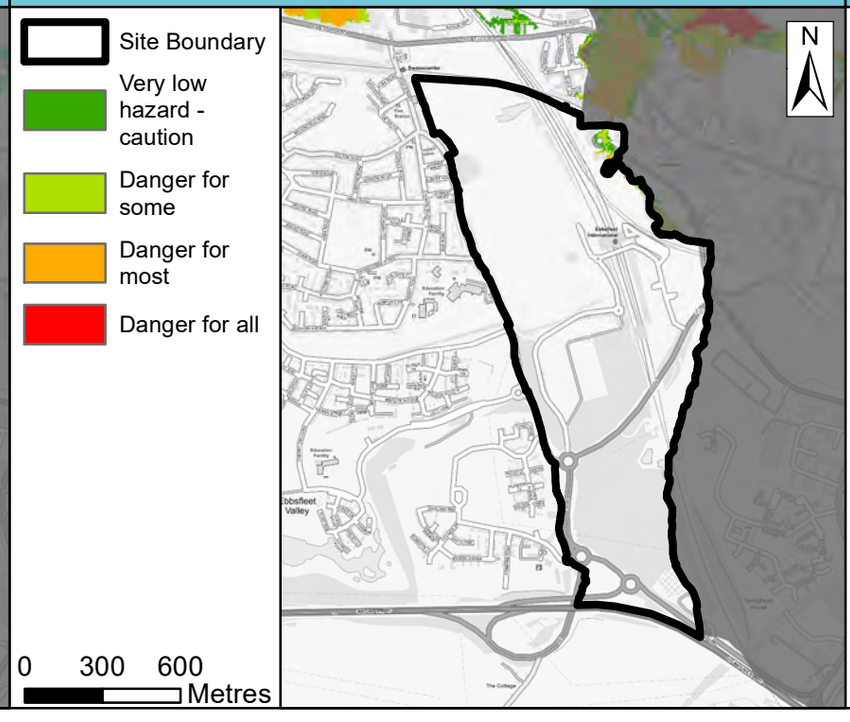

Site name	
Site area (ha)	171.06

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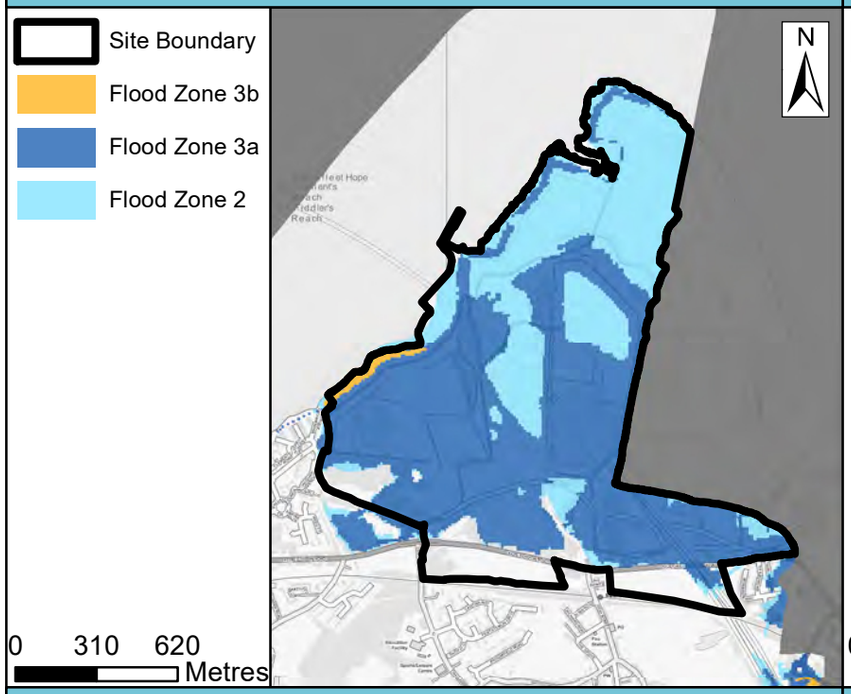

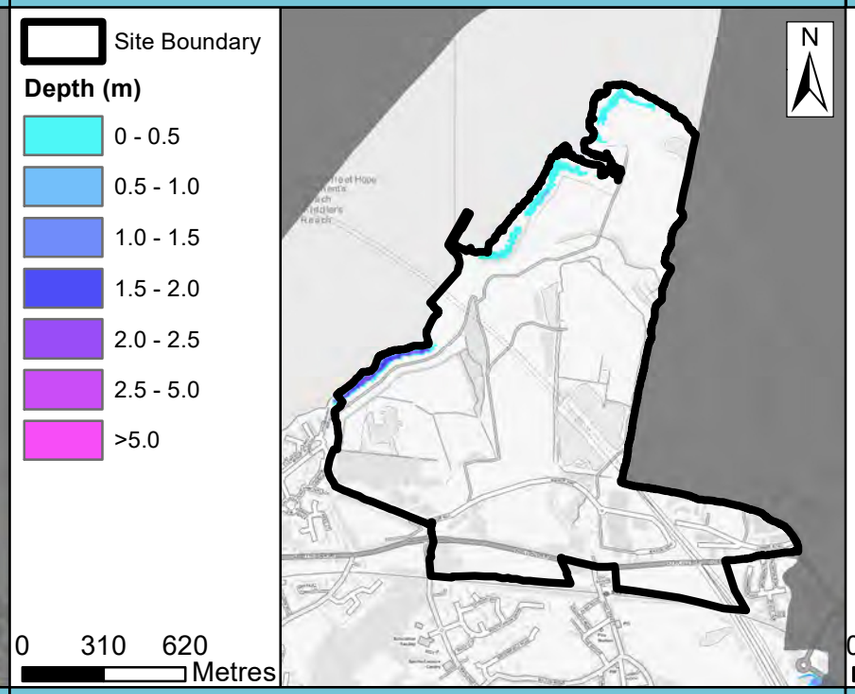

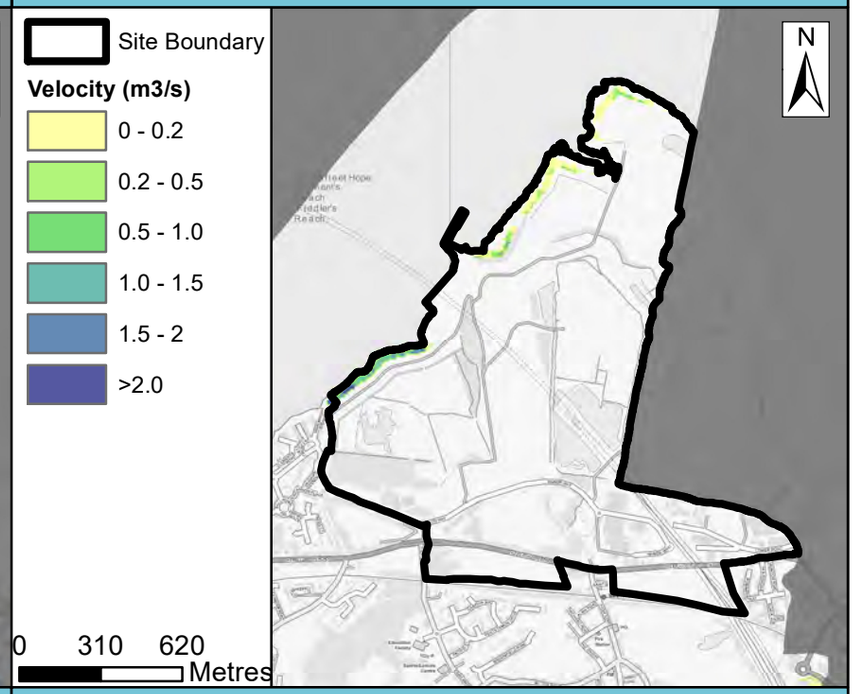

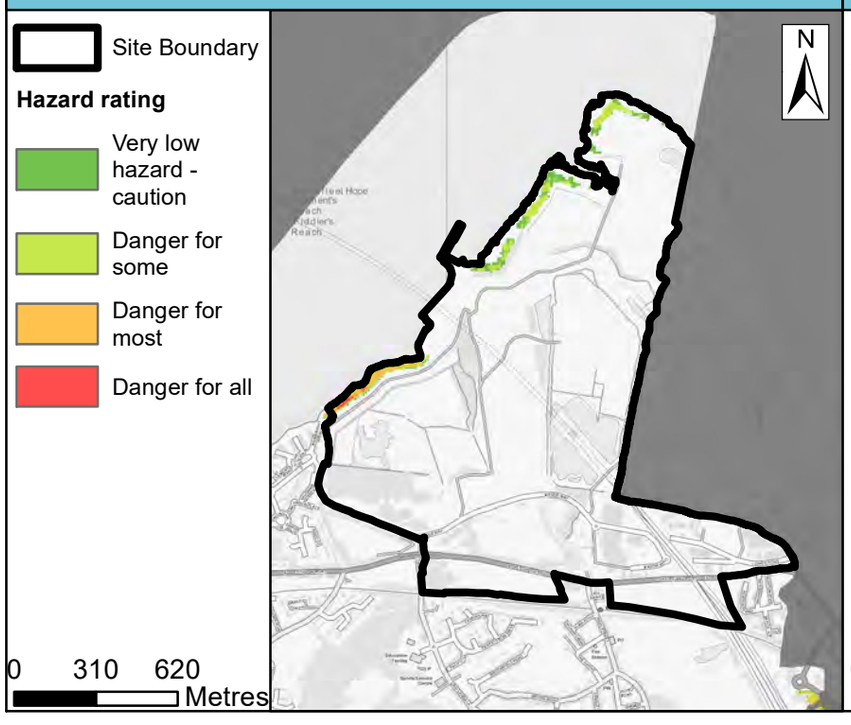

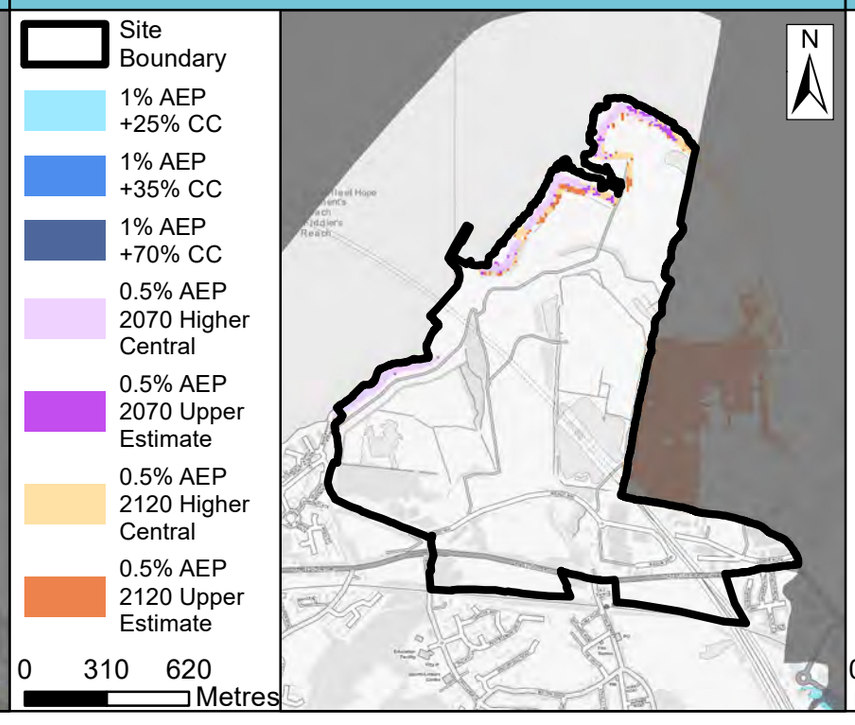

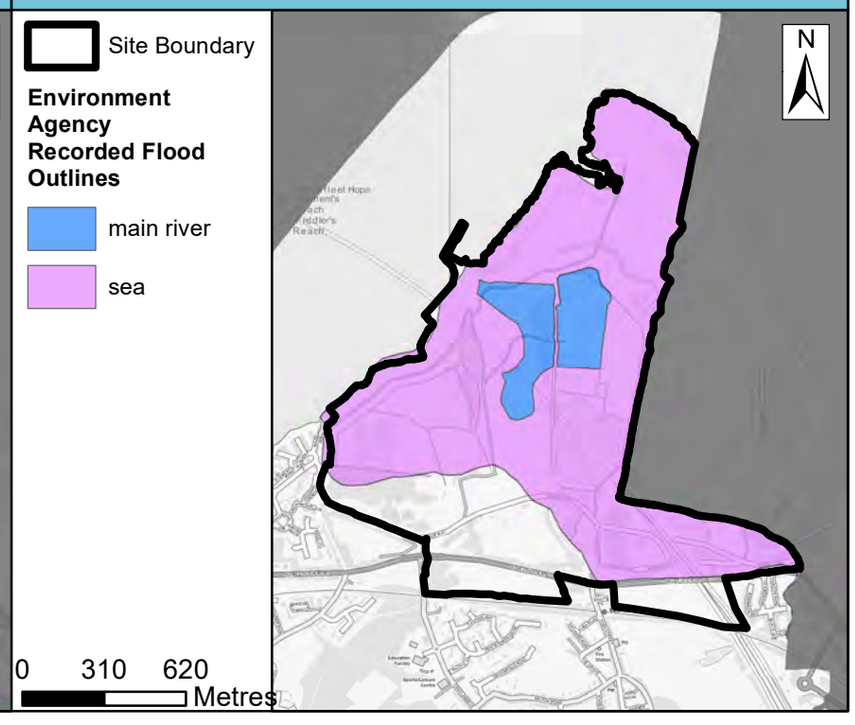

Site name	
Site area (ha)	171.06

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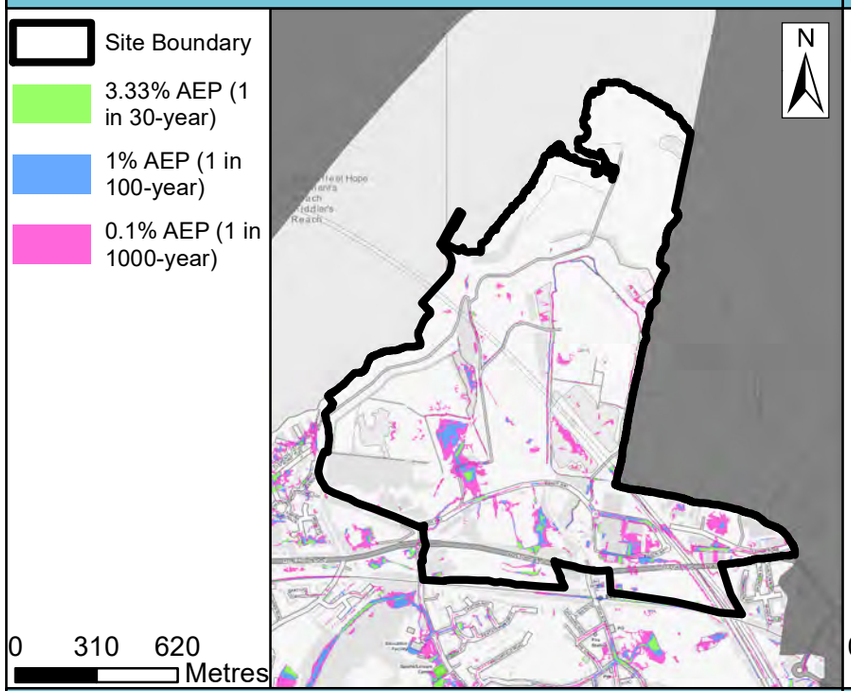

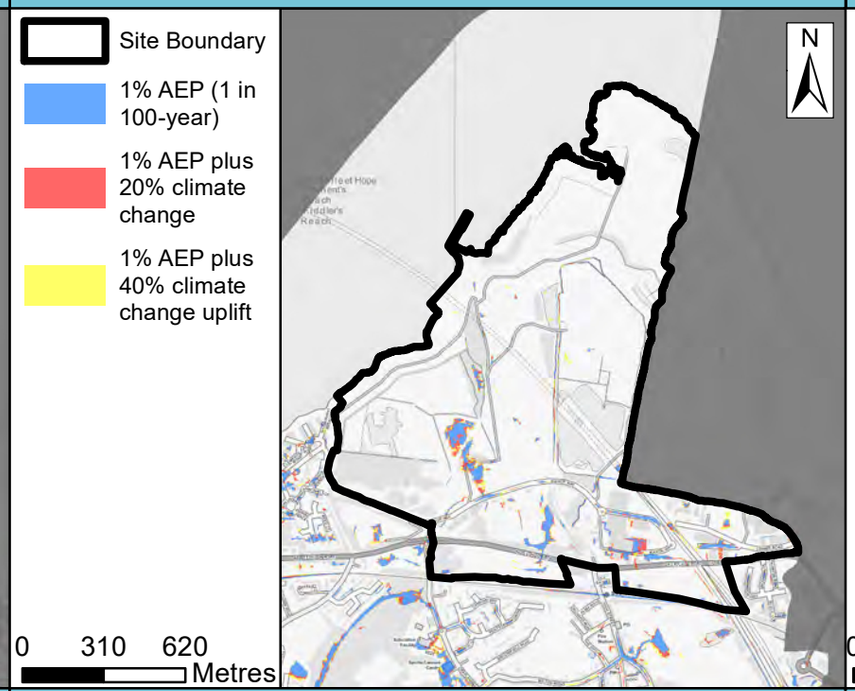

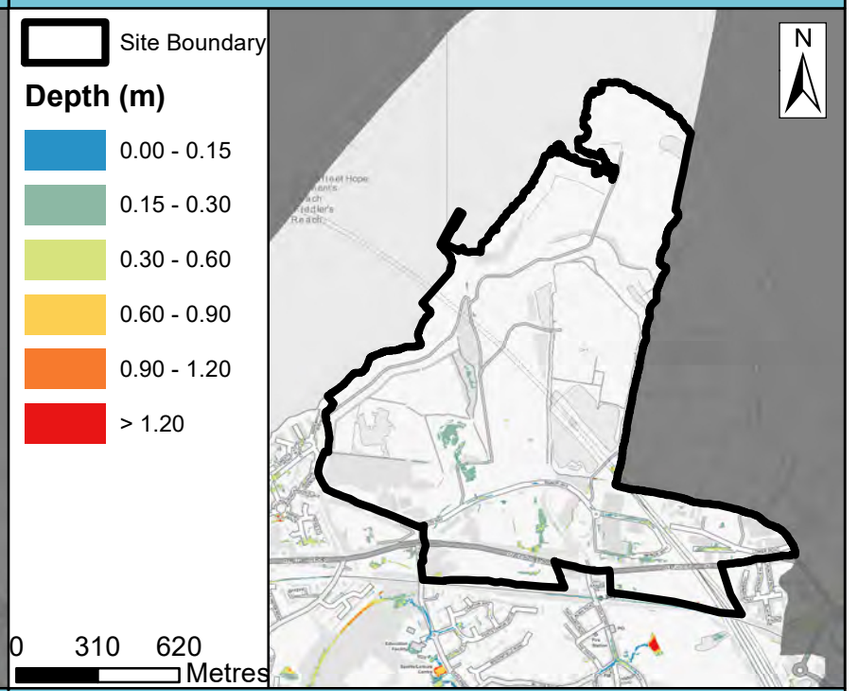

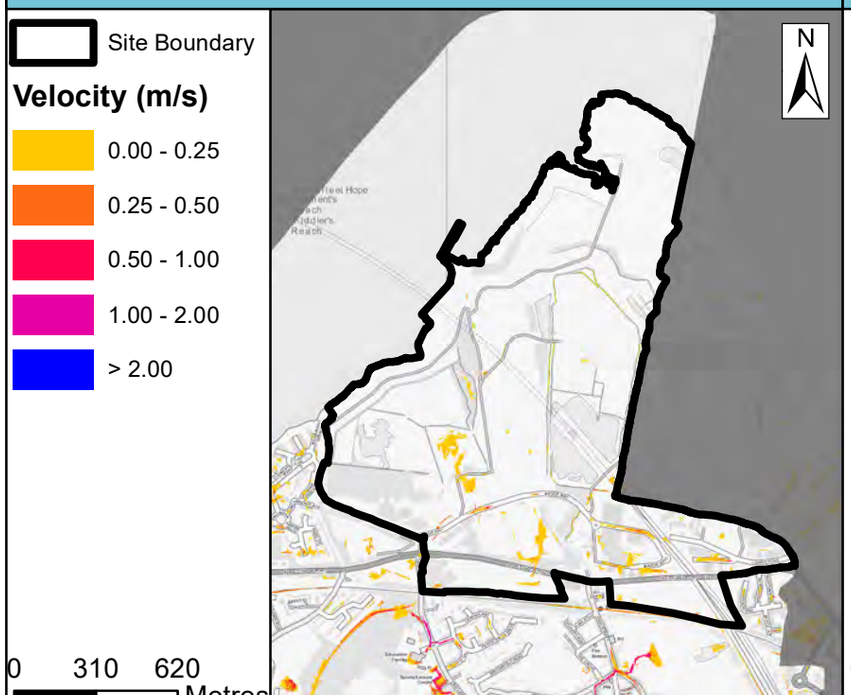

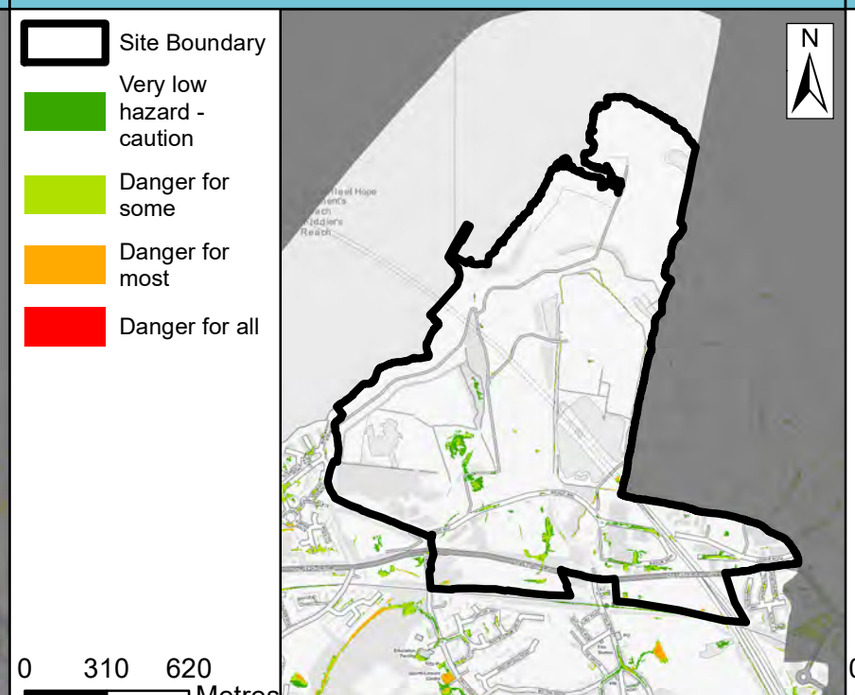

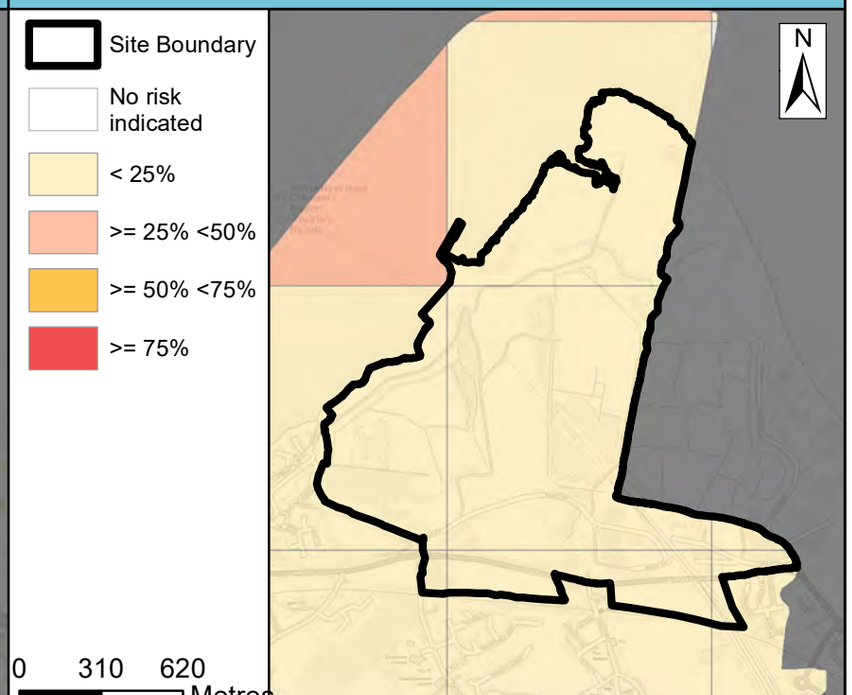

Site name	
Site area (ha)	171.06

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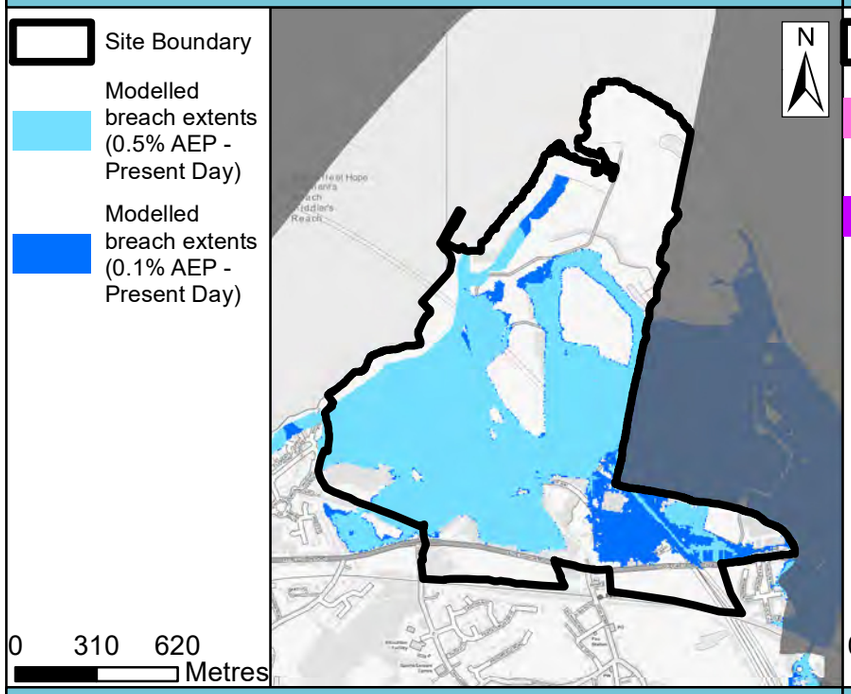

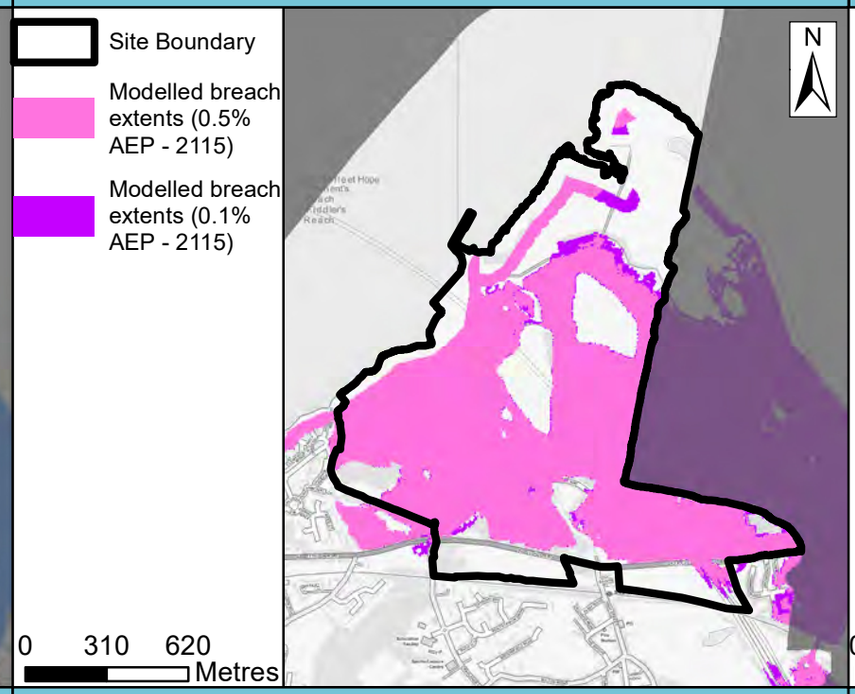

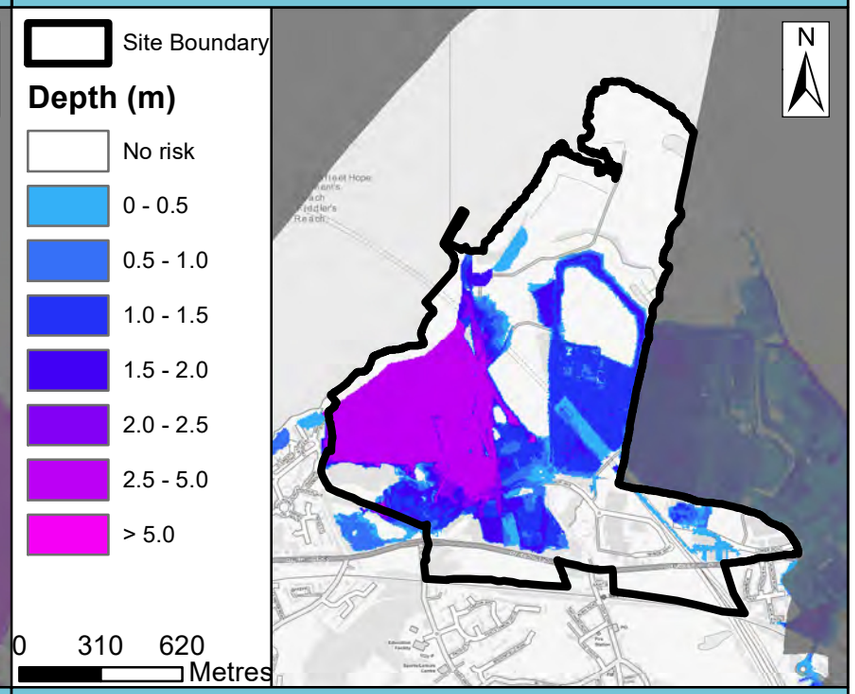

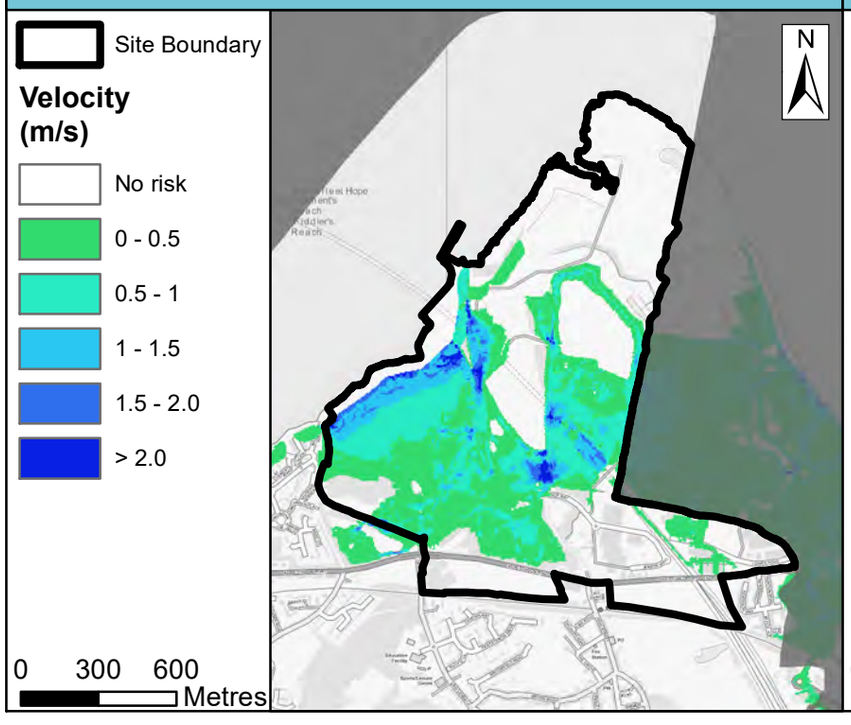

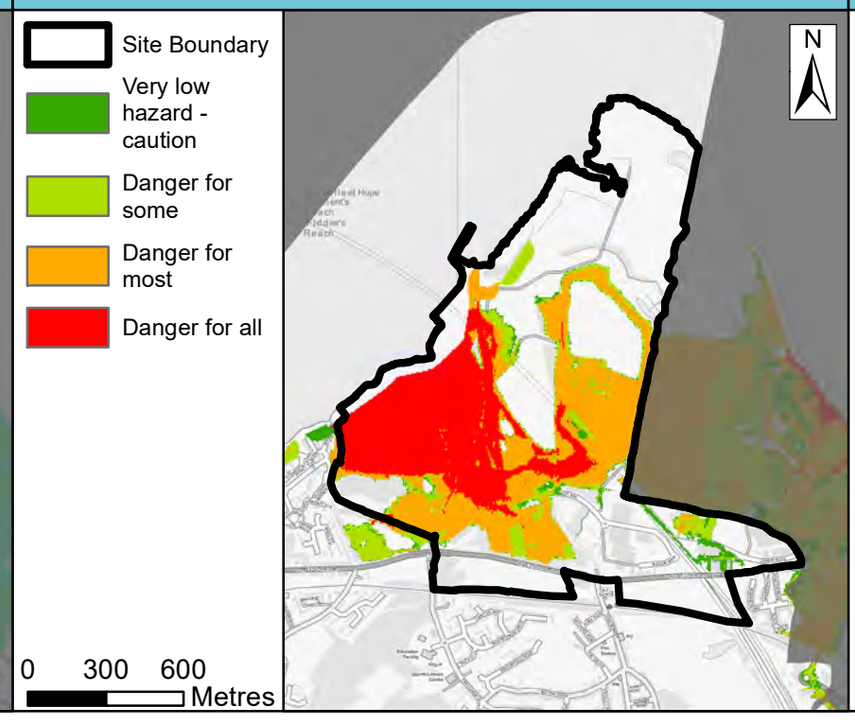

Site name	
Site area (ha)	45.58

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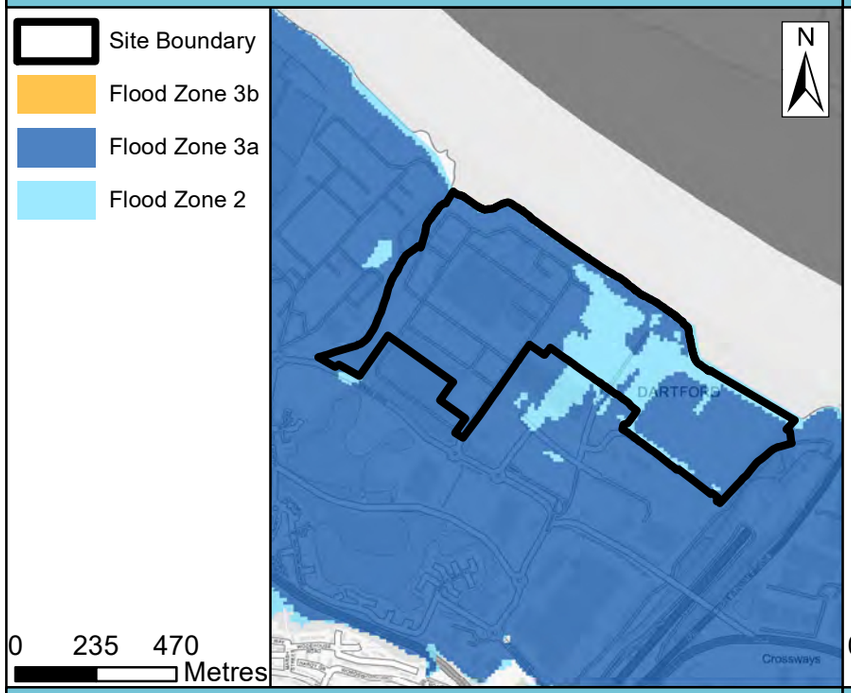

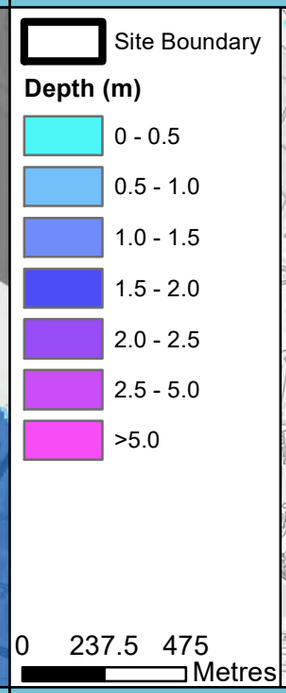

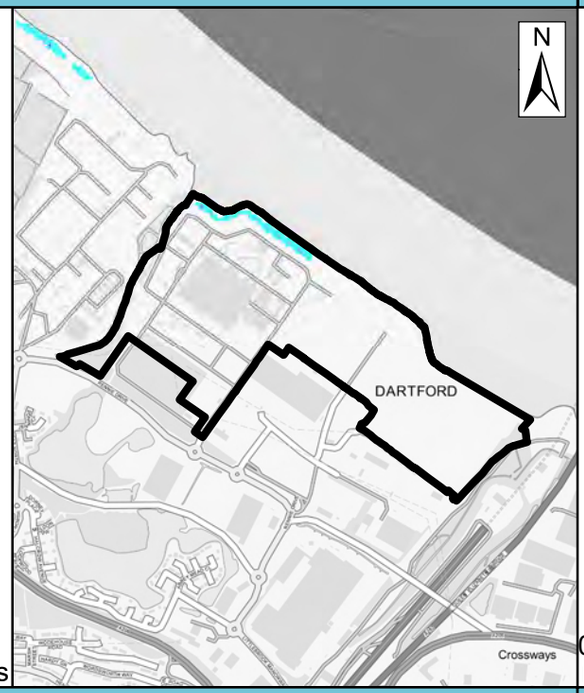

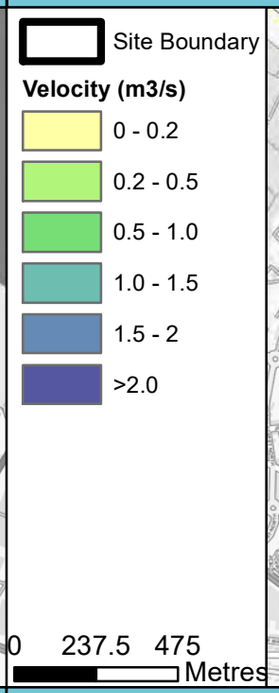

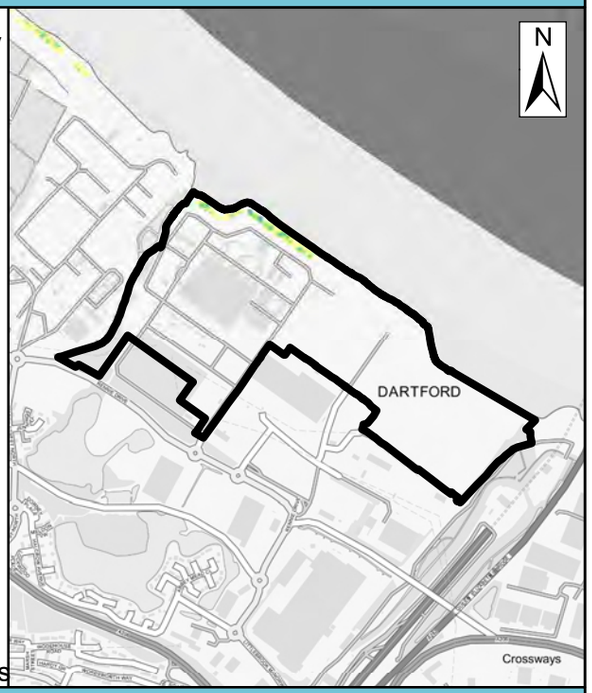

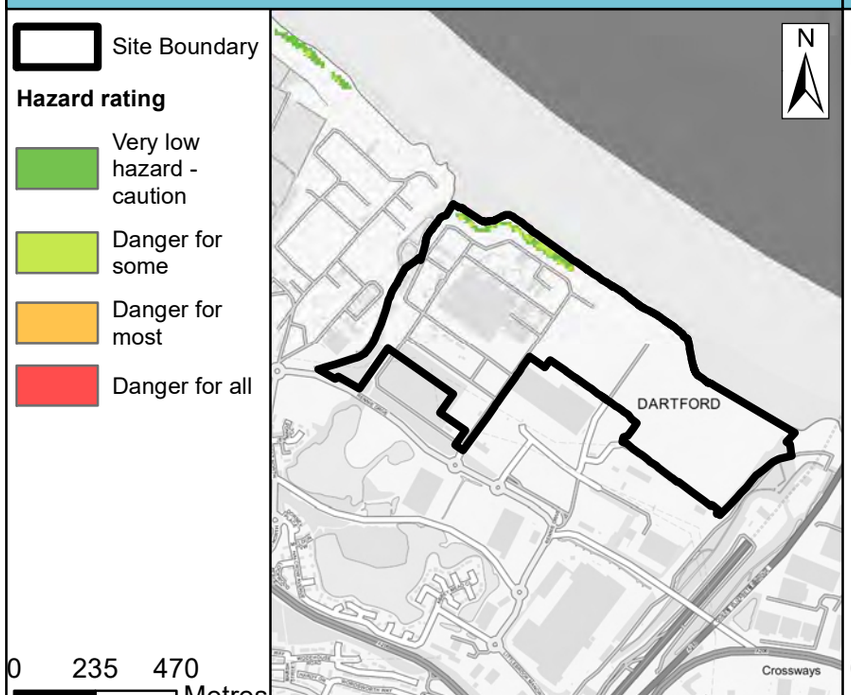

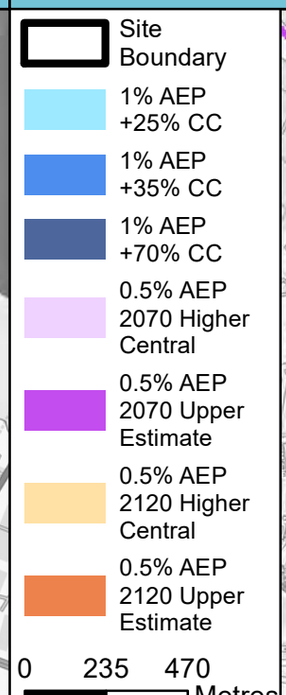

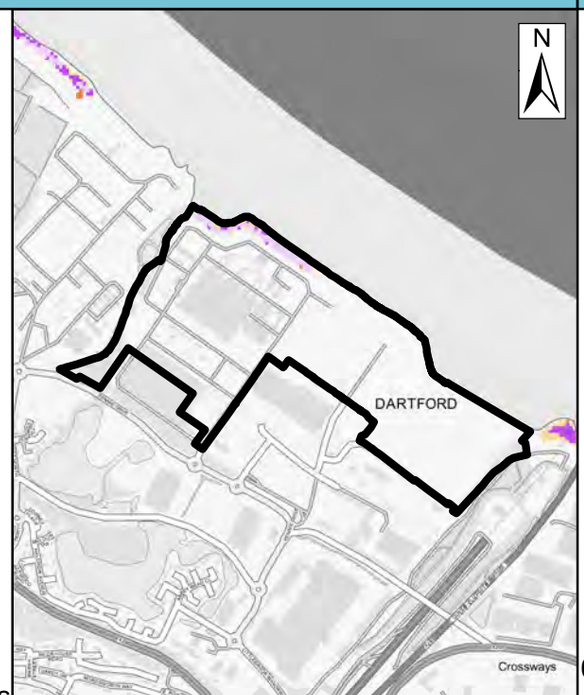

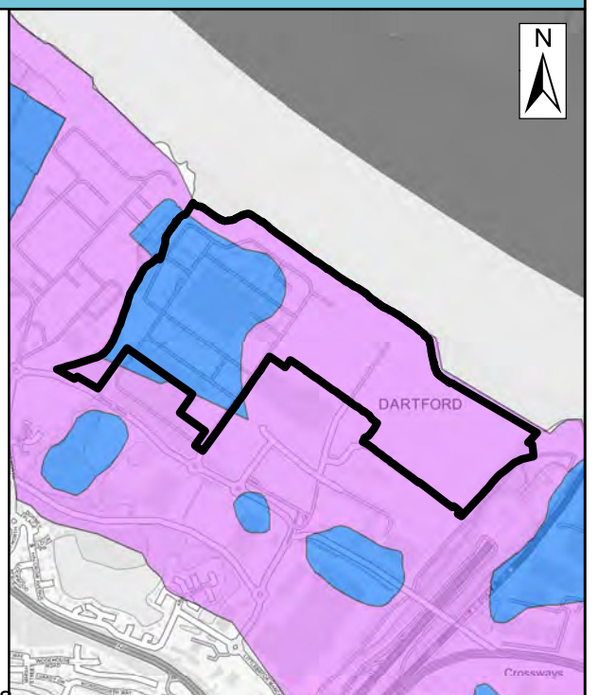

Site name	
Site area (ha)	45.58

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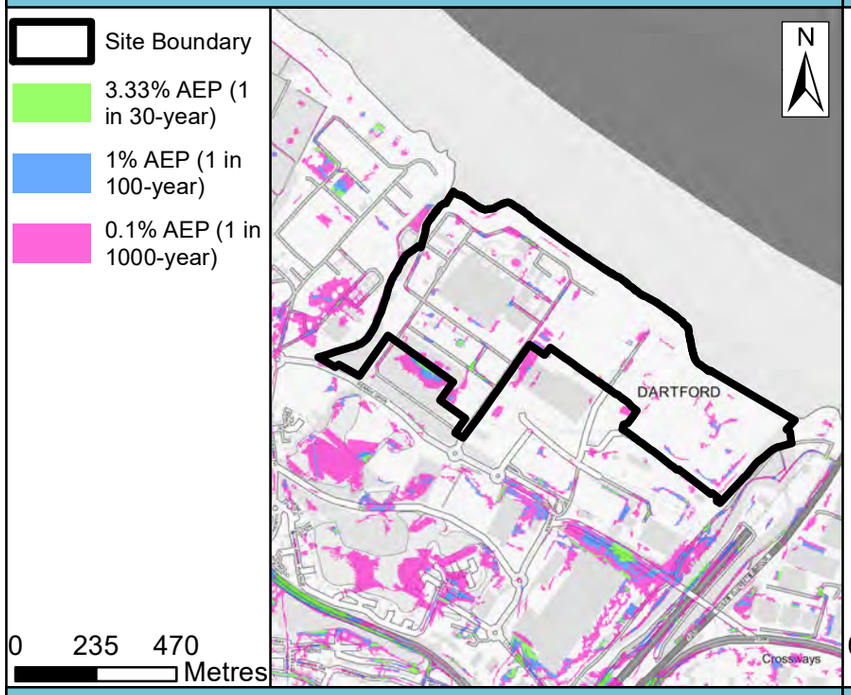

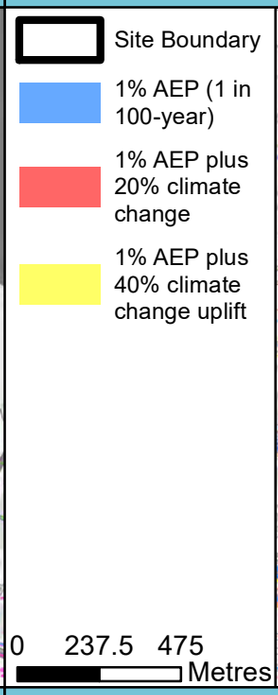

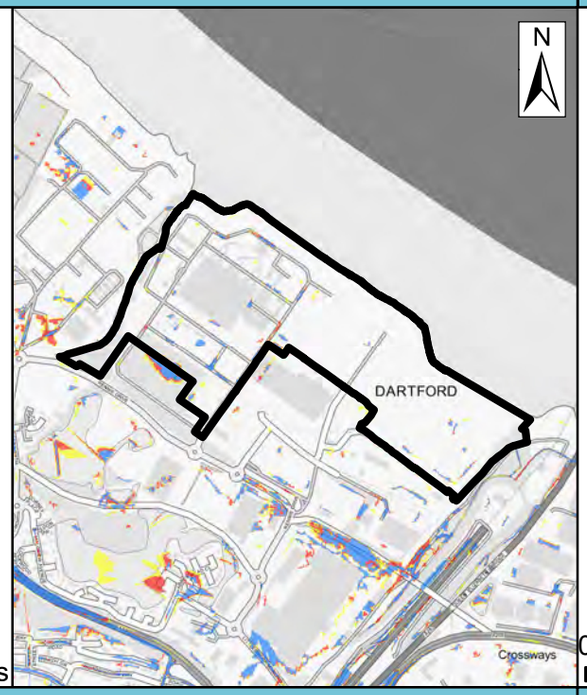

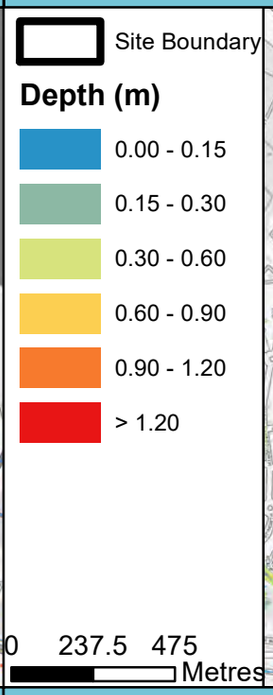

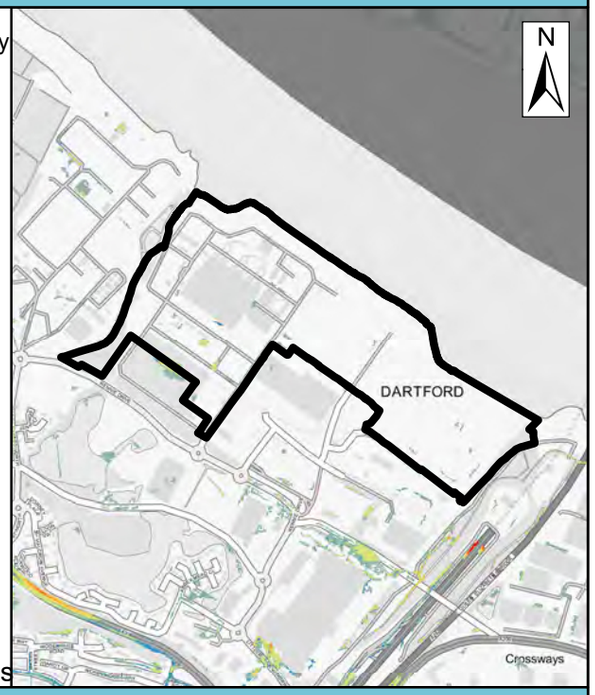

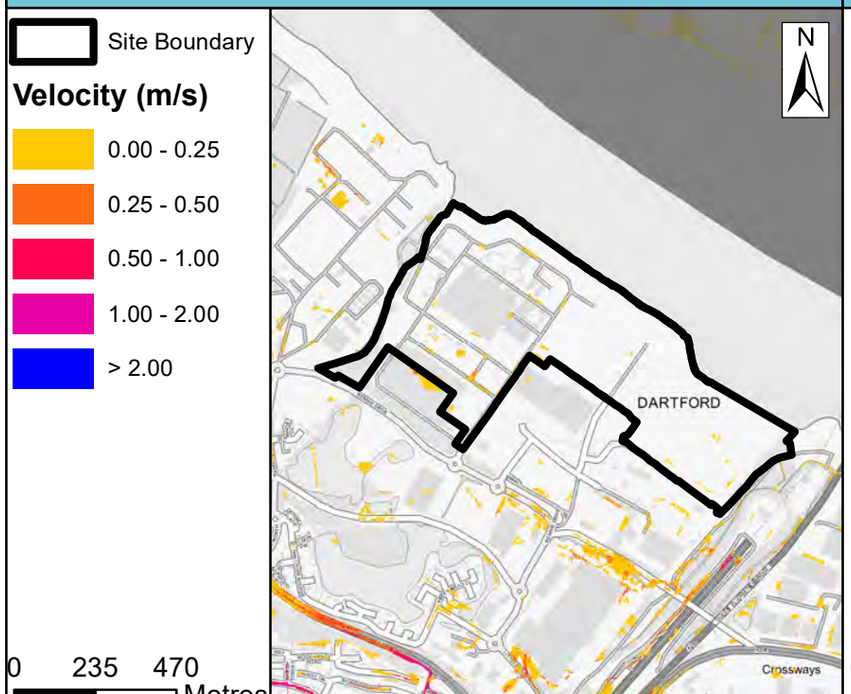

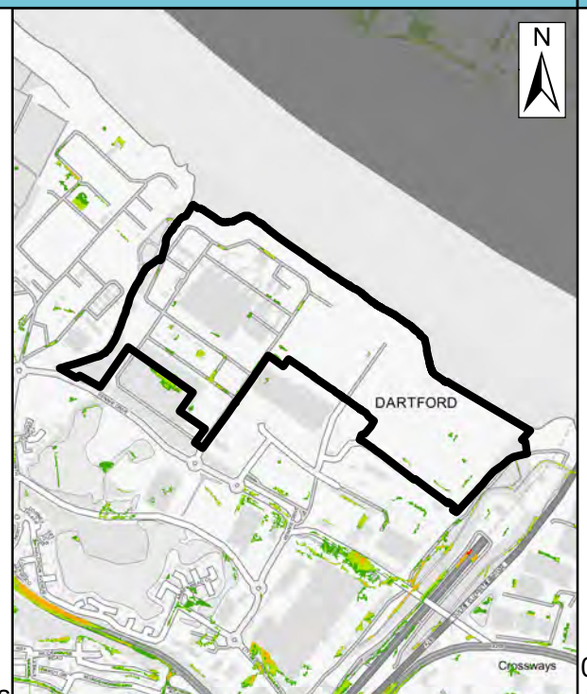

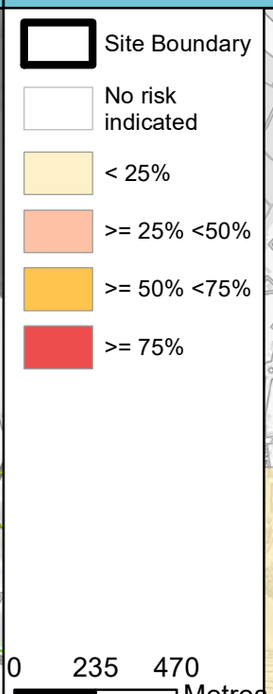

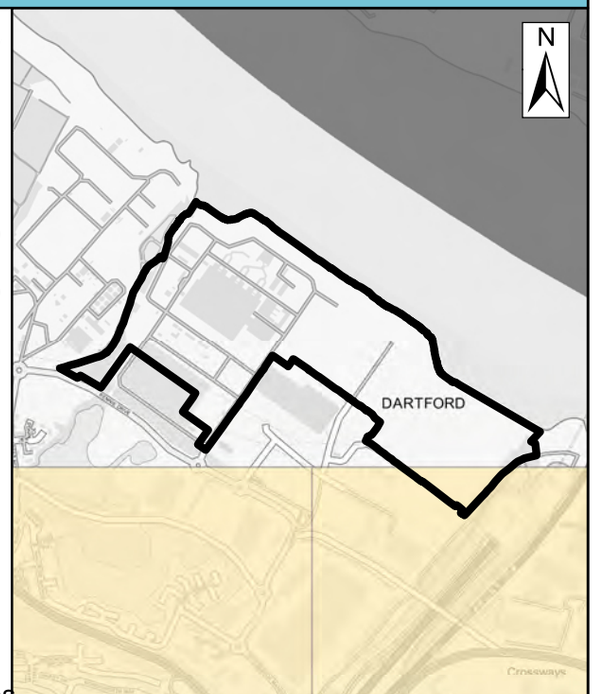

Site name	
Site area (ha)	45.58

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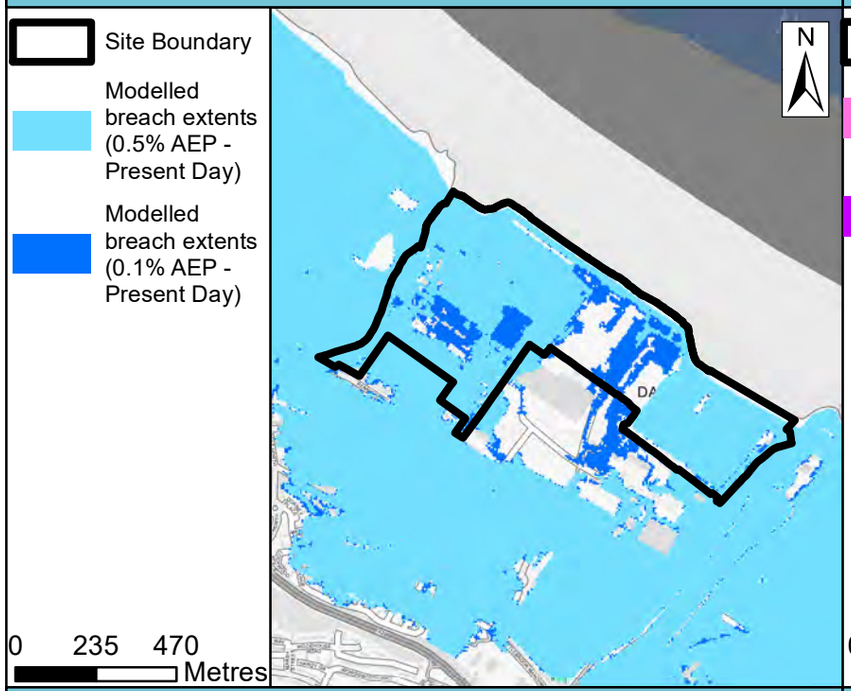

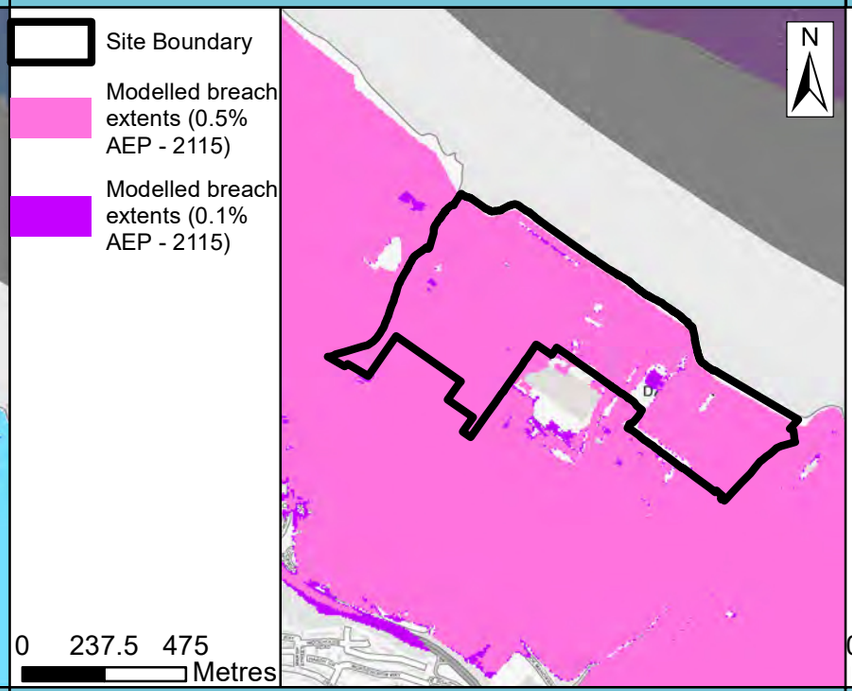

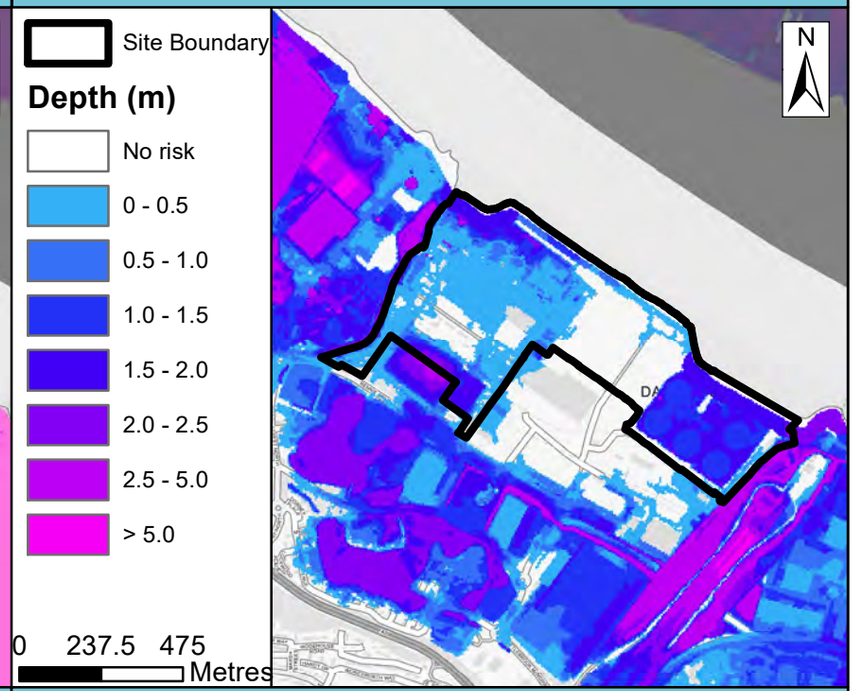

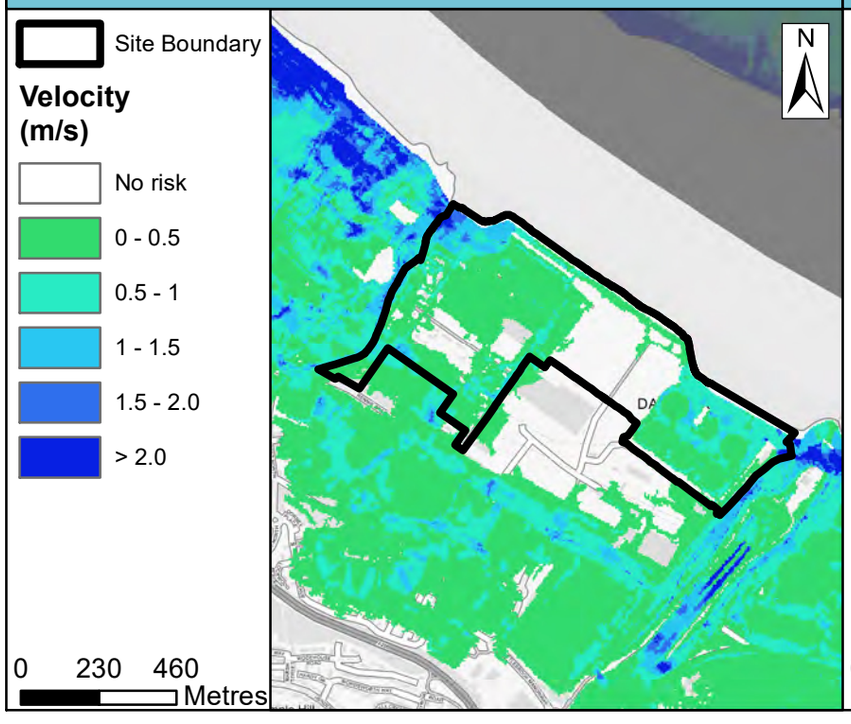

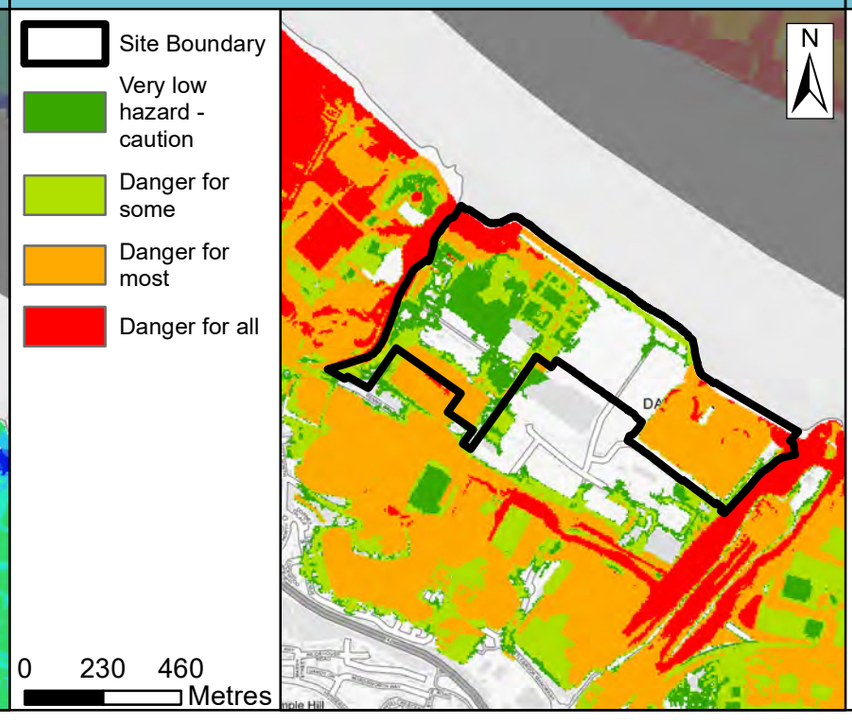

Site name	
Site area (ha)	0.57

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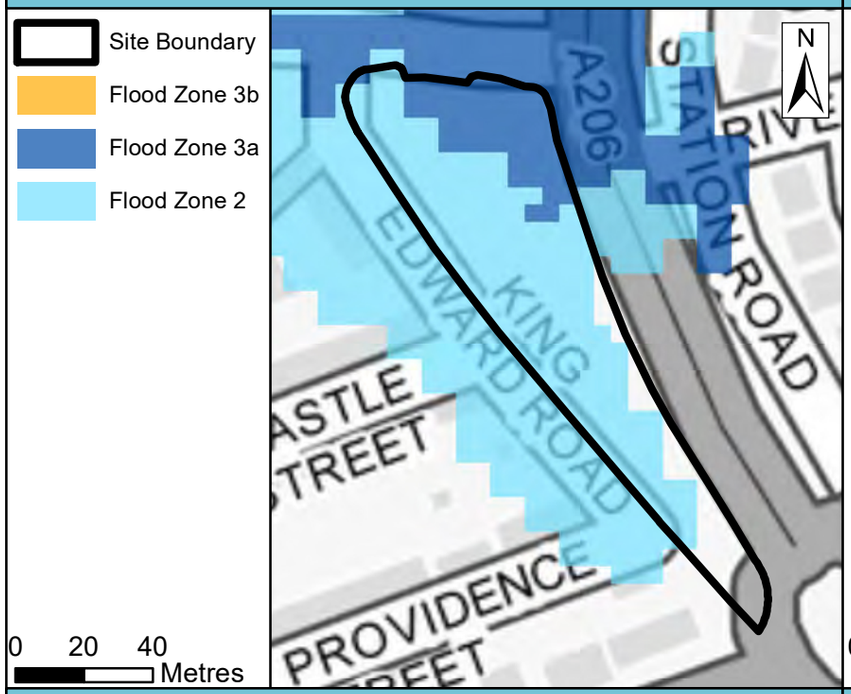

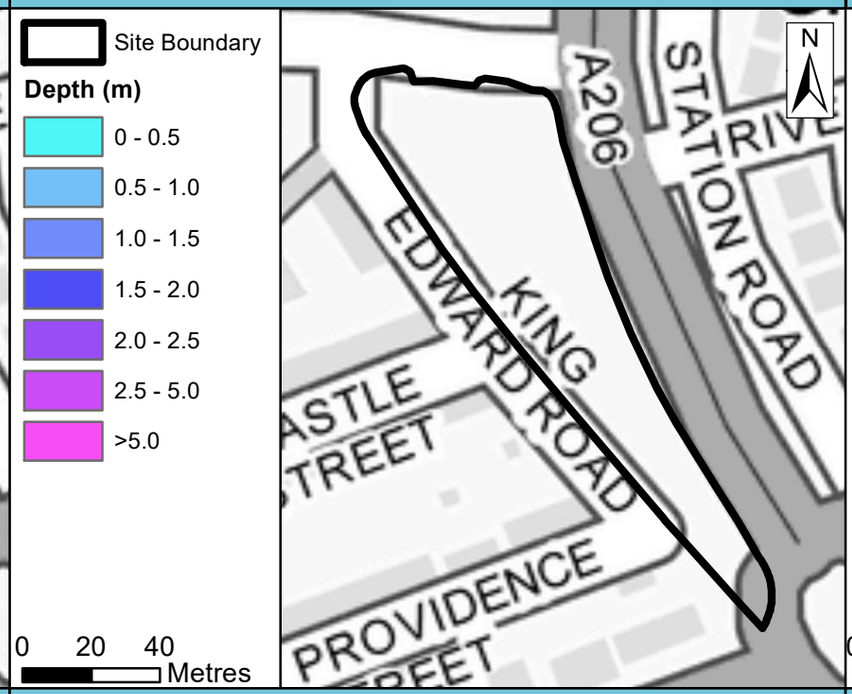

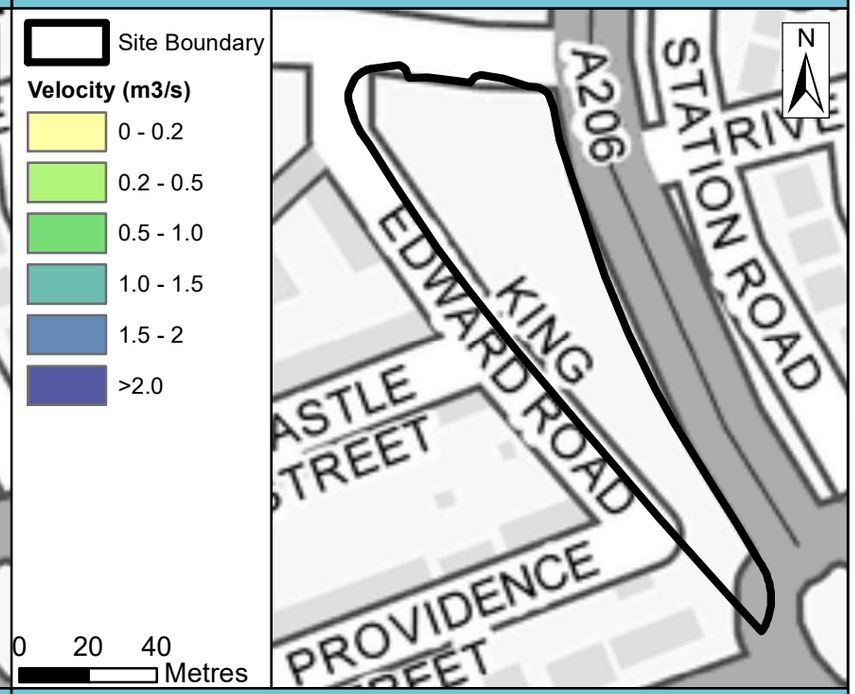

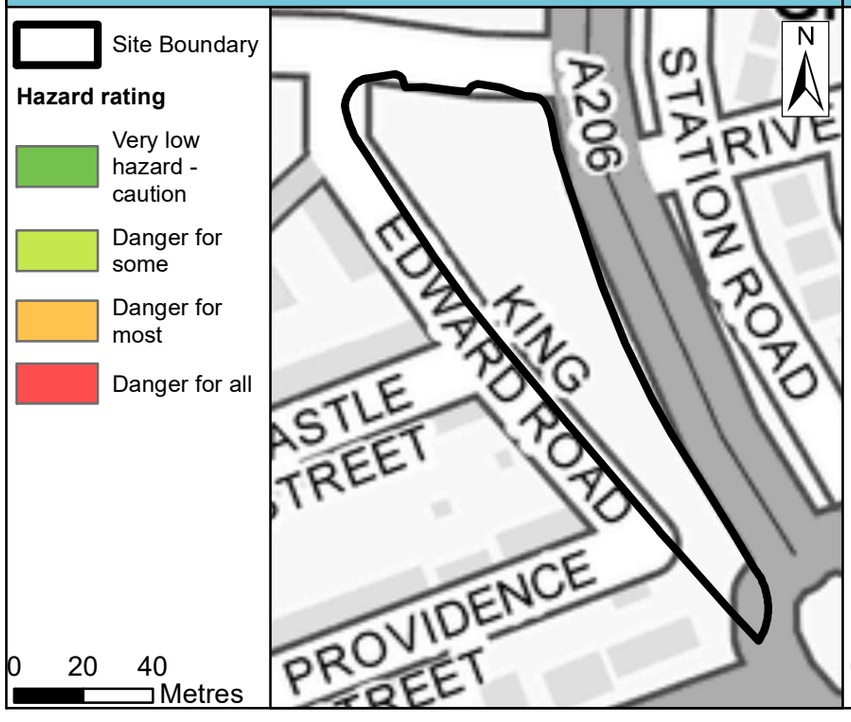

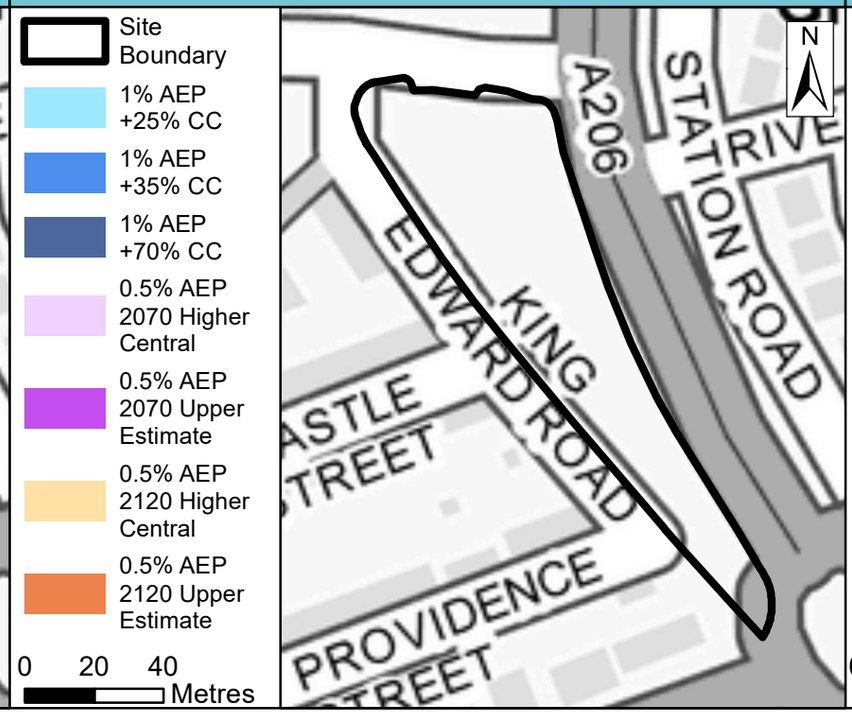

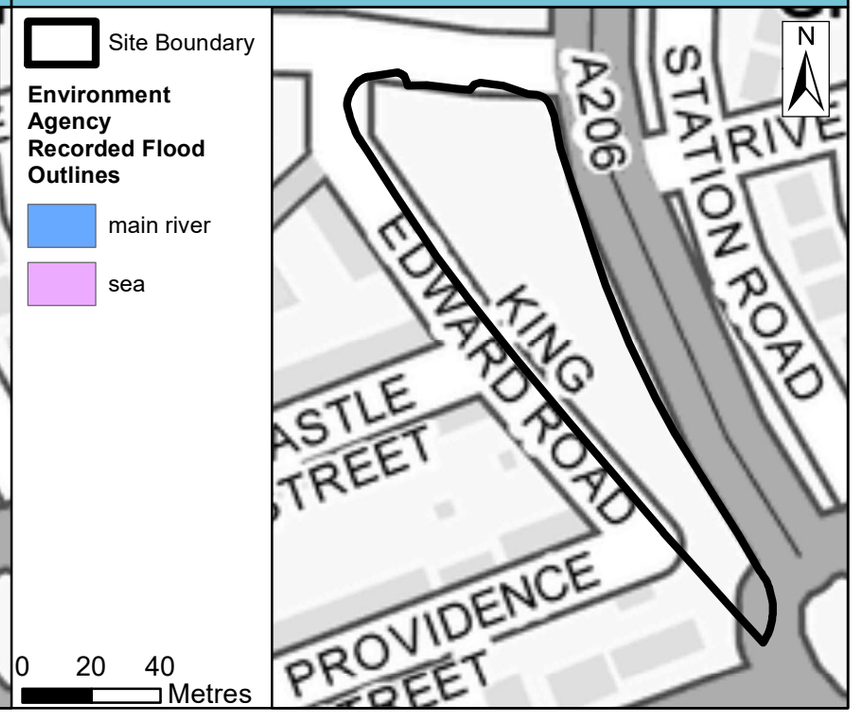

Site name	
Site area (ha)	0.57

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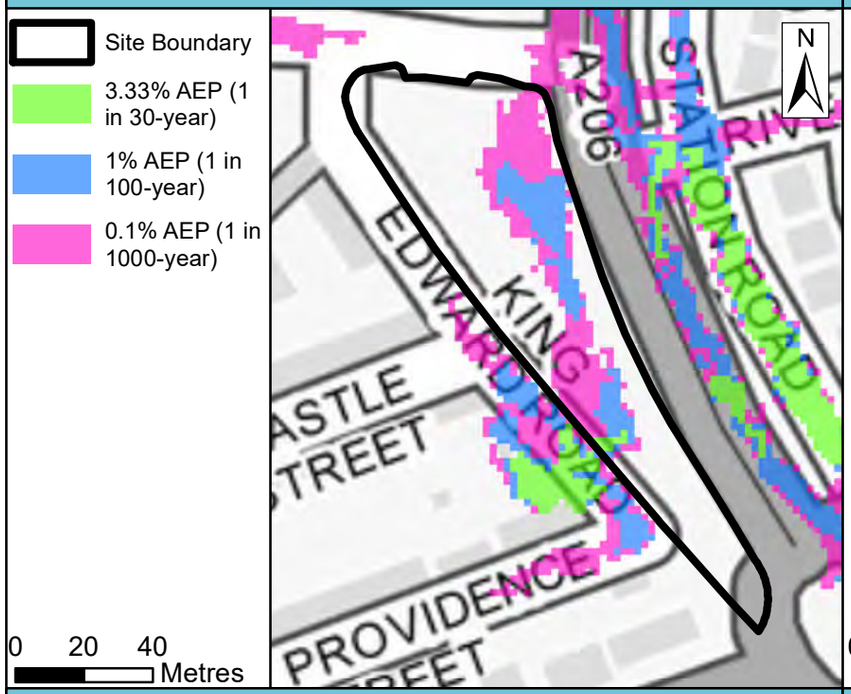

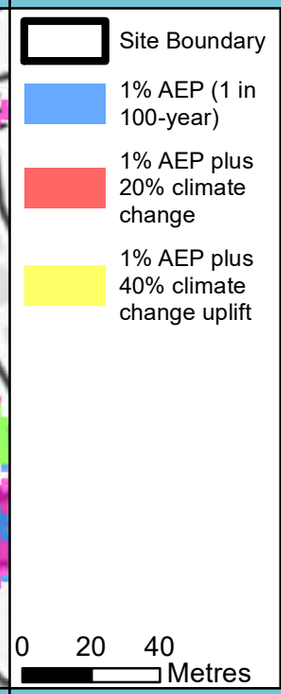

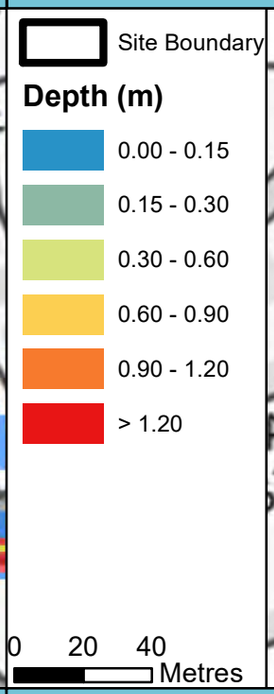

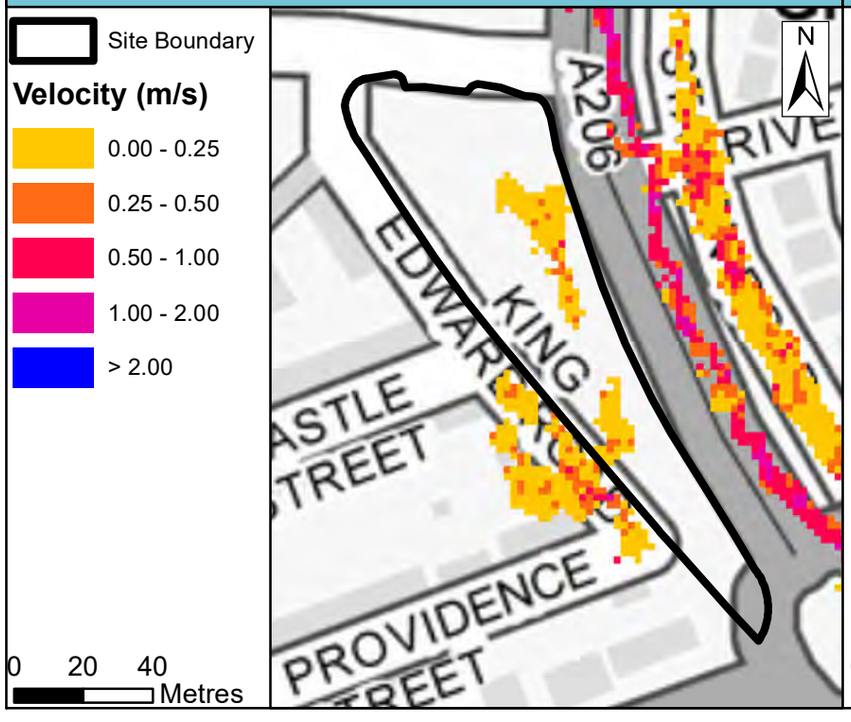

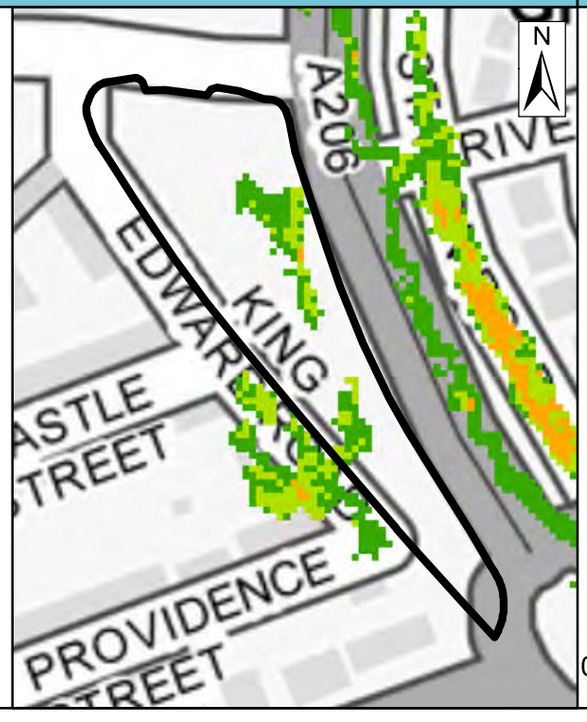

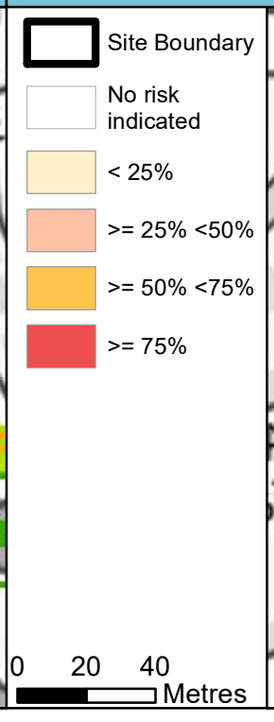

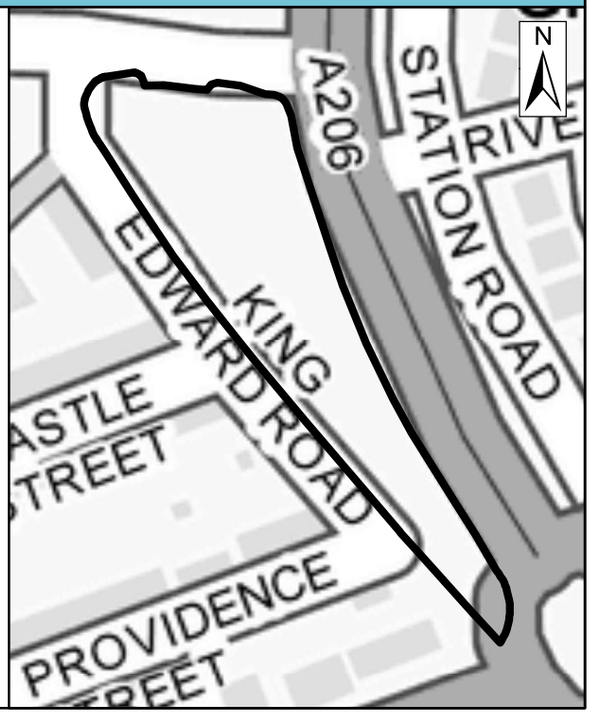

Site name	
Site area (ha)	0.57

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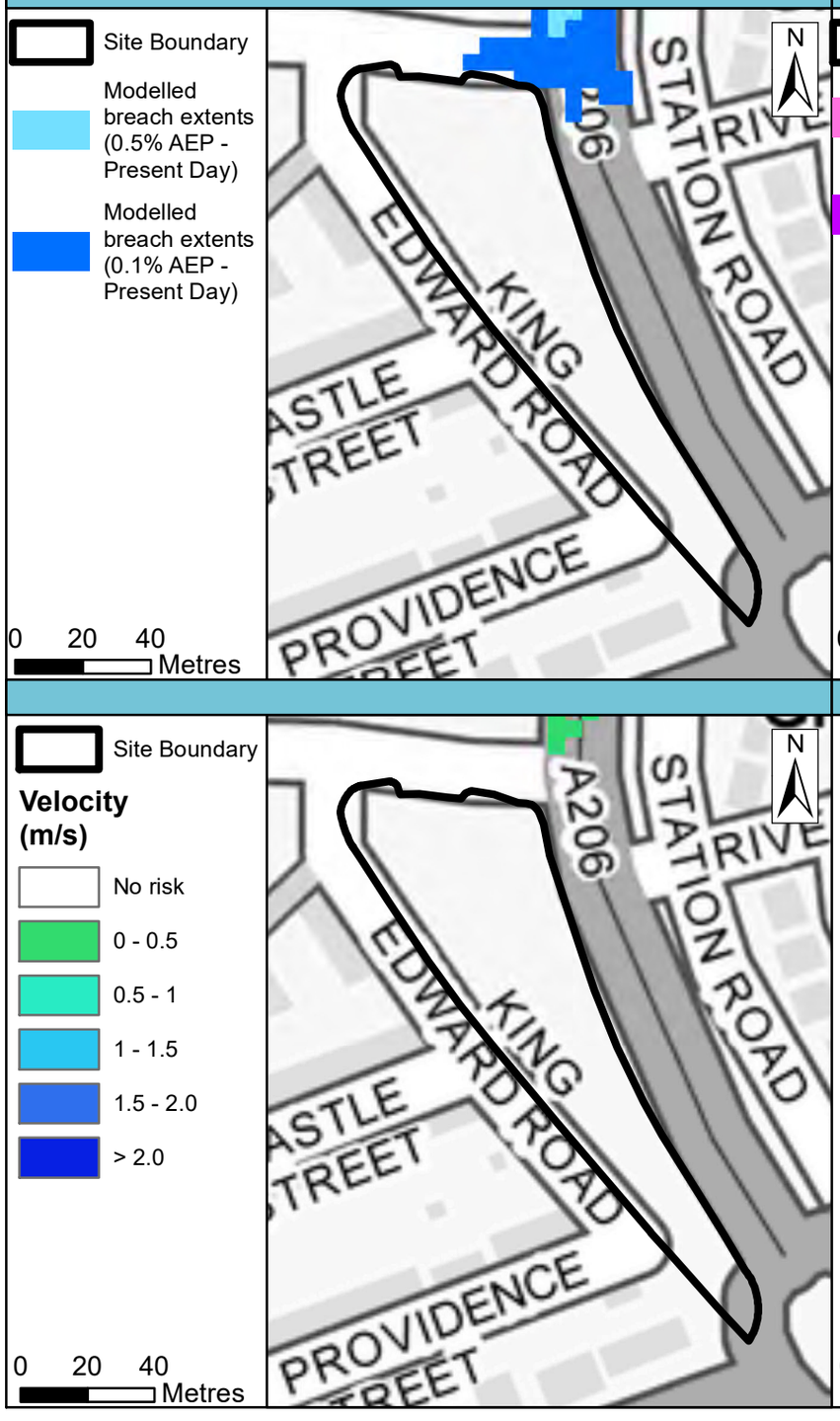

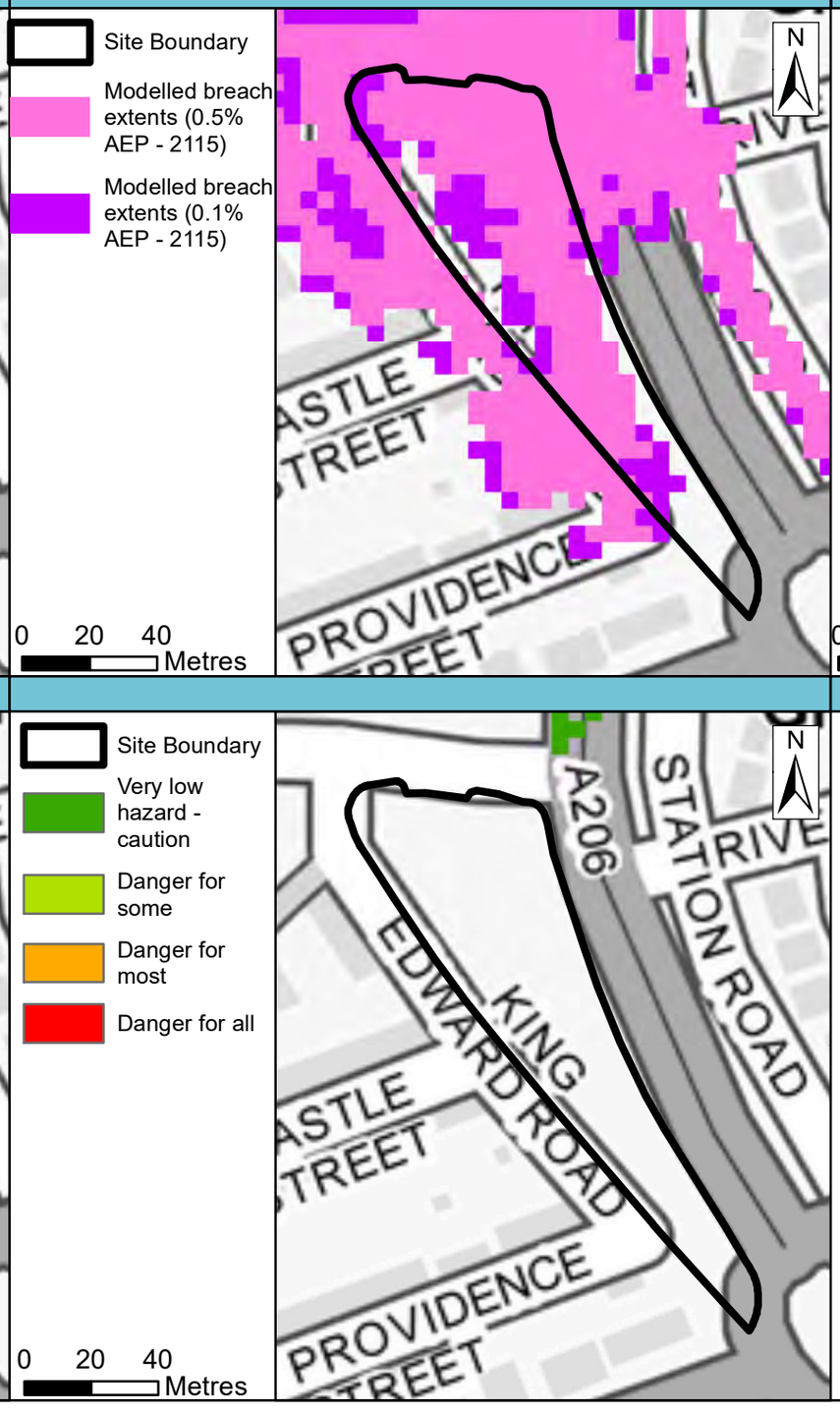

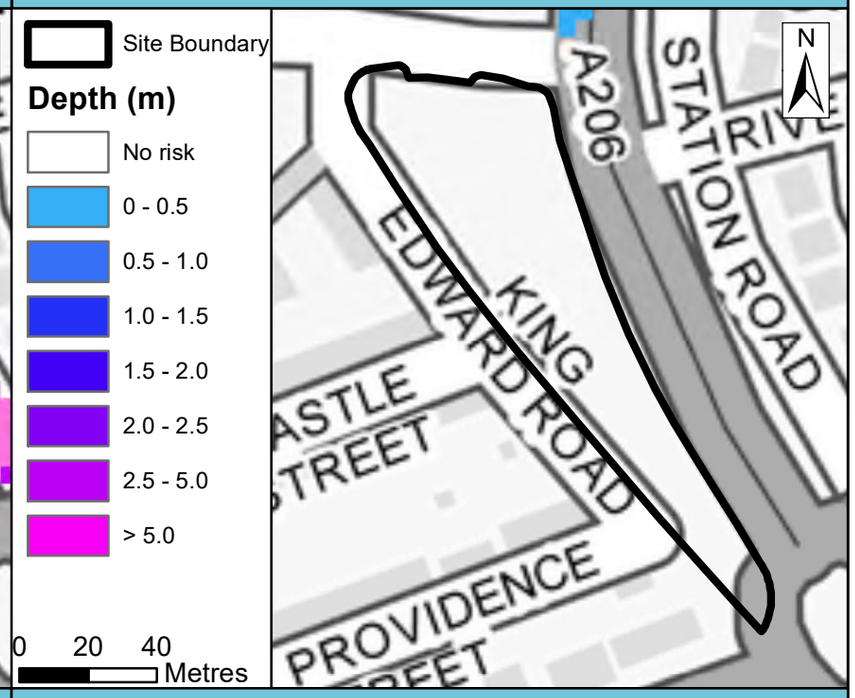

SFRA: APPENDIX O

SFRA USER GUIDE

Flood risk source/ information source	Relevant sections of this SFRA	Result	Level of concern	Recommendations	Sequential and Exception Tests
Fluvial / Tidal (Flood Zones)	6 - Sources of information used in preparing the SFRA 7 - Understanding the risk in the study area	Significant proportion (e.g. greater than 50%) of site in Flood Zones (2 and 3)	High	Residential development on a site in this zone is unlikely to be appropriate unless the site is in an area benefitting from defence and can be made safe for the intended lifespan.	Sites in these categories should be explicitly addressed in a Sequential Test and may require preparation of further evidence to substantiate that Exception Test can be satisfied. Evidence from a Level 2 SFRA is required to demonstrate that the principle of development is supported.
		A proportion (e.g. less than 50%) of site in Flood Zones (2 and 3)	Medium	Residential development may be appropriate, sequential approach should be applied to avoid developing in flood zones as far as reasonable. Parts of the site within flood zone 1 should also be reviewed against the criteria described below.	
		Site located in Flood Zone 1	Medium	Residential development is probably appropriate in this zone, however catchments <3km^2 in area are not covered by the Environment Agency Flood Zones and there may be a risk of flooding from small watercourses and/or other sources. These should be considered in conjunction with the DRN data and data on other sources of flooding. The surface water data in particular often highlights areas at risk of flooding from these smaller watercourses.	
Fluvial / Tidal - Climate change	5 - Climate change 6 - Sources of information used in preparing the SFRA 7- Understanding the risk in the study area	Significant proportion (e.g. greater than 50%) of site at risk of flooding from the future 1% AEP event	High	Residential development is unlikely to be appropriate unless the site is in an area benefitting from defence. Consideration should be given to the Standard of Protection of existing defences in relation to future climate change and any other measures necessary to provide appropriate standards of protection to proposed development.	Sites in these categories should be explicitly addressed in a Sequential Test and may require preparation of further evidence to substantiate that Exception Test can be satisfied. Evidence from a Level 2 SFRA is required to demonstrate that the principle of development is supported.
		A proportion (e.g. less than 50%) of site at risk of flooding from the future 1% AEP event	Medium	Residential development may be appropriate, sequential approach should be applied to avoid developing in the areas at risk of flooding as much as reasonable. Consideration should be given to the Standard of Protection of any defences in relation to future climate change and the commitment to deliver the required standards.	
		Site not at risk of flooding from the future 1% AEP event	Medium	Residential development is probably appropriate in this risk area, however this will depend on the present-day fluvial / tidal risk - refer to fluvial / tidal flood zone recommendations	
Fluvial / Tidal - Climate change proxy	5 - Climate change 6 - Sources of information used in preparing the SFRA 7- Understanding the risk in the study area	Significant proportion (e.g. greater than 50%) of site at risk of flooding from the 0.1% AEP event when used as a proxy for climate change	High	Residential development is unlikely to be appropriate unless the site is in an area benefitting from defence. Consideration should be given to the Standard of Protection of existing defences in relation to future climate change and any other measures necessary to provide appropriate standards of protection to proposed development.	Sites in these categories should be explicitly addressed in a Sequential Test and may require preparation of further evidence to substantiate that Exception Test can be satisfied. Evidence from a Level 2 SFRA (including detailed modelling of the impact of climate change) is required to demonstrate that the principle of development is supported.
		A proportion (e.g. less than 50%) of site at risk of flooding from the 0.1% AEP event when used as a proxy for climate change	Medium	Residential development may be appropriate, sequential approach should be applied to avoid developing in the areas at risk of flooding as much as reasonable. Consideration should be given to the Standard of Protection of any defences in relation to future climate change and the commitment to deliver the required standards.	
		Site not at risk of flooding from the 0.1% AEP event when used as a proxy for climate change	Low	Residential development is likely to be appropriate based on this criterion.	
Surface Water	6 - Sources of information used in preparing the SFRA 7 - Understanding the risk in the study area	Significant proportion (e.g. >50%) of site is affected by surface water flooding (across all three surface water events)	High	Development on a site in this risk area is unlikely to be appropriate unless measures (including drainage) are in place to control overland flow.	Evidence may be required from a Level 2 SFRA to demonstrate that the principle of development is supported
		A proportion (e.g. <50%) of site is affected by surface water flooding (across all three surface water events)	Medium	Development may be appropriate and consultations should be held with the Lead Local Flood Authority.	
		No risk of surface water flooding	Low	Development is likely to be appropriate based on this criterion.	
Surface Water - Climate change	5 - Climate change 6 - Sources of information used in preparing the SFRA 7 - Understanding the risk in the study area	Significant proportion (e.g. greater than 50%) of site at risk of surface water flooding from the future 1% AEP event	High	Development on a site in this risk area is unlikely to be appropriate unless measures (including drainage) are in place to control overland flow.	Evidence may be required from a Level 2 SFRA to demonstrate that the principle of development is supported
		A proportion (e.g. less than 50%) of site at risk of surface water flooding from the future 1% AEP event	Medium	Development may be appropriate and consultations should be held with the Lead Local Flood Authority.	
		Site not at risk of surface water flooding from the future 1% AEP event	Low	Development may be appropriate in this risk area, however this will depend on the present-day flood risk - refer to surface water recommendations	
Groundwater	6 - Sources of information used in preparing the SFRA 7 - Understanding the risk in the study area	Historic records of groundwater flooding within or near a site	Medium	The effect of this will depend on the location and historic evidence of known problems - a site-specific FRA should consider overland flow paths once groundwater has emerged. It is unlikely that infiltration SuDS will be appropriate and groundwater monitoring should be recommended.	
		Risk of flooding from groundwater is not negligible	Medium	Development might be appropriate but a site-specific FRA should consider groundwater risk. A high likelihood may mean infiltration SuDS are not appropriate and groundwater monitoring should be recommended.	
		Negligible risk of flooding from groundwater	Low	Development is likely to be appropriate in this risk area, however as groundwater datasets are generally produced nationally it is recommended that ground investigations are carried out and reported on within a site-specific FRA where this is required (known to be a problem locally).	
Reservoir inundation	6 - Sources of information used in preparing the SFRA 7 - Understanding the risk in the study area	Maximum risk of flooding from reservoir inundation (is greater than 2m depth or 2m/s velocity)	High	Development on a site in this risk area might not be appropriate - this will be heavily dependent on the state of repair of the dam and the long term commitment to its management and maintenance. If development is considered, the local authority Emergency Planning team should be consulted to confirm that proposals can be safely implemented.	Level 2 SFRA required to provide evidence that the principle of development is supported
		Maximum risk of flooding from reservoir inundation (is less than 2 m depth or 2 m/s velocity)	Medium	Risk of flooding from reservoirs should not rule out development as the likelihood of reservoir breach is low, however risk should still be considered by the developer at site-specific FRA stage and an emergency plan is likely to be required. The local authority Emergency Planning team should be consulted.	
		No risk of reservoir inundation	Low	Development is likely to be appropriate in this risk area.	
Historic flood map	6 - Sources of information used in preparing the SFRA 7 - Understanding the risk in the study area	Any part of site within historic flood extents	Medium	Sites located in areas that have historically flooded might be appropriate for Development, however further investigation will be required regarding the severity and frequency of the historic flooding and accuracy of the historic flood extent. This should be used alongside other information in the Level 1 SFRA to decide whether the site is appropriate for allocation. Technical work will be required to inform this at the site-specific FRA stage.	
		No risk of historic flooding	Low	Development is likely to be appropriate based on this criterion.	
Detailed River Network	6 - Sources of information used in preparing the SFRA 7 - Understanding the risk in the study area	Any part of site within 20m of a watercourse (from the Detailed River Network dataset)	Medium	Sites located within 20m of the DRN line might be appropriate for development. Where the DRN goes through or adjacent to a site, the Flood Zones and surface water map should also be considered to further determine the effect on development. Where the DRN is located away from a site and land slopes down towards the site, development may be less appropriate than a site where land slopes down towards the watercourse and away from the site.	
		Site not within 20m of a watercourse (from the Detailed River Network dataset)	Low / Medium	Development is likely to be appropriate in this risk area, however not all watercourses are mapped on the Detailed River Network dataset, smaller drains may not be mapped and may need to be considered along with flood risk from other sources.	
Areas benefitting from flood defence	8 - Flood defences	Any part of the site is within an area benefiting from defence	Advisory	Development in this risk area is normally appropriate in principle, however, the performance of formal defences and residual flood risk will need to be considered and consideration given to the commitment and contributions required to maintain the appropriate standard of protection.	Level 2 SFRA required to provide evidence that the principle of development is supported
		The site is not in an area benefiting from defence	Low	Development is likely to be appropriate in this risk area if there is no risk of flooding from other sources on the site. See other recommendations if there is any risk of flooding.	
Cumulative impacts	13 - Level 1 Assessment	High - Any part of the site is within a High Cumulative Impact Zone	Medium	Development could be considered as appropriate, however, specific planning policy recommendations may need to be formulated. Drainage and flood risk reduction opportunities will probably need to be considered further within these catchments that may have financial and/or land take implications for the site and allay concerns of existing communities potentially at risk.	Level 2 SFRA may be required to provide evidence that the principle of development is supported
		Medium - Any part of the site is within a Medium Cumulative Impact Zone (unless the site is also within a High Zone)	Low / Medium	Development is likely to be appropriate in these risk areas, however if a Medium score has been identified based on a high amount of development then specific planning policy recommendations may need to be formulated. Drainage and flood risk reduction opportunities may need to be considered further within these catchments that may have financial and/or land take implications for the site.	
		Low - Any site not partially or fully within either High or Medium Cumulative Impact Zones	Low	Development is likely to be appropriate in this risk area.	